AD-A084 457 OFFICE OF NAVAL RESEARCH SCIENTIFIC LIAISON GROUP AP--ETC F/G 8/1
ONR TOKYO SCIENTIFIC BULLETIN, VOLUME 4, NUMBER 4, OCTOBER-DECE--ETC(U)
DEC 79 R J MARCUS, E MOHRI

UNCLASSIFIED NL

1 OF 2
AD A
084 457

OCTOBER TO DECEMBER 1979

VOL. 4, NO. 4

SCIENTIFIC BULLETIN

DEPARTMENT OF THE NAVY OFFICE OF NAVAL RESEARCH TOKYO

NAVSO P-3580

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: ONR/T VOL. 4, NO. 4	2. GOVT ACCESSION NO.: AD-A084457	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): (6) ONR TOKYO SCIENTIFIC BULLETIN, Volume 4, Number 4, October-December 1979		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): (10) Rudolph J. Marcus, Scientific Director Eunice Mohri, Associate Editor		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Office of Naval Research Scientific Liaison Group American Embassy APO San Francisco 96503		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: (11) Dec '79
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE: October/December 1979
		13. NUMBER OF PAGES: (12) 151
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this Report): UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Indian marine science	Indian geophysical oceanography
Indian physical oceanography	Indian marine instrumentation
Indian chemical oceanography	Indian ocean engineering
Indian biological oceanography	Indian research vessel
Indian geological oceanography	Indian OSTA

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This is a quarterly publication presenting articles covering recent developments in Far Eastern (particularly Japanese) scientific research. It is hoped that these reports (which do not constitute part of the scientific literature) will prove to be of value to scientists by providing items of interest well in advance of the usual scientific publications. The articles are written primarily by members of the staff of ONR Tokyo,

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-014-6601

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

19. (Key Words (cont.)

Chinese physics research
Chinese nuclear research
Chinese electronic research
Korean geology
Korean mudflats
Korean oceanography
Pacific sciences
Sleep disorders
Biological rhythms
Sleep data
Sleep-inducing substances
Sleep deprivation
Free radicals
Spectroscopy
Reaction Chemistry
Two-dimensional systems
Electronics
Low-dimensional systems
Cryogenics
Semiconductors
Infrared spectroscopy
Cosmic-ray physics
Particle physics
High-energy physics
Nucleosynthesis
Cosmic-ray electrons
Air showers
X-ray astronomy
Cosmic-ray muons
Solar modulation
Solar particle acceleration
Epidemiology
DNA
Xeroderma pigmentosum
Radiology
Fast-neutron therapy
Circuits and systems
Signal processing
Computer science
Physics
Rydberg atoms
Materials research
Non-metallic conductors
Metallurgy
Chemistry
Geomorphology

20. Abstract (contd.)

with certain reports also being contributed by visiting stateside scientists. Occasionally a regional scientist will be invited to submit an article covering his own work, considered to be of special interest.

CONTRIBUTORS

Francis A. Richards recently returned to his position of Professor of Oceanography at the University of Washington after completing a two-year assignment with ONR Tokyo. His research interests in chemical oceanography include analysis of sea water, plankton pigments, oxygen-deficient and sulfide-bearing environments in the ocean, and interrelationships among the branches of oceanography through chemistry.

Eligius A. Wolicki is Associate Superintendent, Radiation Technology Division at the Naval Research Laboratory. He is a member of the International Advisory Committee for the Ion Beam Surface Layer Analysis Conference. His research interests include nuclear physics, radiation detectors, ion accelerators, ion beam analysis of surfaces, ion implantation, applications of nuclear techniques, and radiation effects.

John T. Wells is assistant professor at the Coastal Studies Institute, Louisiana State University. His research interests are in the areas of fine-grained sediment dynamics and coastal processes in shallow-water environments.

Oscar K. Huh is an associate professor at Coastal Studies Institute, Louisiana State University. His research interests are in the remote sensing of coastal oceanographic and atmospheric processes, specifically the effects of cold-air outbreaks and resulting changes in water masses, currents, and the atmospheric marine boundary layer.

Ned A. Ostenso serves in dual positions as Deputy Assistant Administrator for Research and Development and Director of the National Sea Grant College Program at the National Oceanic and Atmospheric Administration. His contributions to earth and marine sciences have brought him many honors, including having a major mountain in Antarctica and a seamount in the Arctic Ocean named after him.

Thomas A. Gosink is a Research Associate with the Geophysical Institute, University of Alaska as well as a Marine Chemist with the Institute of Marine Science at the University of Alaska, both at the Fairbanks campus. He received his bachelor's degree from Miami University, Oxford, Ohio. He holds a M.S. degree from Massachusetts Institute of Technology, and a PhD from Oregon State University, all in chemistry. Dr. Gosink served as a visiting professor at the University of Southhampton, England in the fall of 1974.

Paul Naitoh is head of the Psychophysiology Branch of the Environmental Division, Naval Health Research Center, San Diego. His research interests are primarily concerned with psychophysiological and biomedical problems of sleep, sleep deprivation, and alcoholism. One of his previous investigations include statistical analyses of multivariate time-series describing various biological rhythms, from oscillatory electrical activities of the brain to circadian fluctuations in bodily functions and task performances. In 1974 he was an invited research associate of Centre National de la Recherche Scientifique of the Centre d'Etudes Bioclimatiques in Strasbourg, France.

J. R. McDonald, as head of the optical diagnostics section of the Chemistry Division at the Naval Research Laboratory, directs a program in three related areas of laser research. During his earlier association with Louisiana State University, he carried out research in the field of excited state dynamics and molecular spectroscopy of polycyclic aeromatic hydrocarbons and also studies vacuum ultraviolet spectroscopy and fluorescence emission processes in small inorganic molecules and ions. In 1970 Dr. McDonald began work at the Naval Research Laboratory studying energy transfer processes, emission spectroscopy and excited state processes in vinyl aeromatic polymer and copolymer systems. In 1974 he joined the Physical Chemistry Branch where he developed a basic research program in excited state dynamics and radiationless transition processes in laser-excited molecular systems. These research efforts have evolved into a research program in photo dissociation processes and the study of radical molecule reaction dynamics and kinetics.

Akira Ishihara is Professor and Chairman, Department of Physics, at State University of New York at Buffalo. He received his Doctor of Science at the University of Tokyo. He has worked at the University of Tokyo, University of Maryland, Polytechnic Institute of New York, University of Brussels, University of Amsterdam, University of Rochester and other places. His research interests include statistical mechanics, solid state and many-body theory, low temperature and polymer physics, and other fields.

Robert J. Wagner, a research physicist in the Semiconductors Branch, Electronics Technology Division, Naval Research Laboratory, has concentrated his activities on the design and utilization of far infrared gas lasers for the study of magneto-optic properties of semiconductors. He was a National Research Council resident research associate at the Naval Research Laboratory from 1967-69. Until 1974 he was primarily interested in small gap semiconductors and since 1975 has been involved in experimental studies of space layers in semiconductors.

Bruce D. McCombe is a research physicist and head of the Semiconductors Branch, Electronics Technology Division, at the Naval Research Laboratory. He came to the Laboratory in 1965 as a National Research Council resident research associate. Since that time he has devoted most of his efforts to magneto-optic studies of solids and photoluminescence in semiconductors. Until 1974 he was mostly interested in small gap semiconductors and from 1975 has been involved in experimental studies of space charge layers in semiconductor devices.

Rein Silberberg is a research physicist at the Laboratory for Cosmic Ray Physics at the Naval Research Laboratory. He is one of the world's leading authorities on cosmic-ray physics, -astrophysics, -biophysics, and their various applications. In September 1979 he received the Navy Meritorious Civil Service Award for developing equations for calculating nuclear spallation cross sections. These are now used in various branches of science, from cosmic rays and geophysics to cancer therapy by heavy ion beams. In 1978 he was Assistant Director of the International School of Cosmic-Ray Astrophysics, Erice, Italy. At the invitation of the Accademia Nazionale dei Lincei in Rome, Silberberg coauthored, with Dr. M. M. Shapiro, a chapter in the Albert Einstein centennial memorial volume to be published in the near future.

George N. Catravas is Chairman of the Biochemistry Department at the Armed Forces Radiobiology Research Institute, Defense Nuclear Agency, Bethesda, Maryland. He is also Adjunct Professor of Biology at the American University, Washington, D.C. His current research interests include effects of ionizing and non-ionizing (microwave) radiation on the central nervous system.

Joseph F. Weiss is Chief of the Physiological Chemistry Division of the Biochemistry Department at the Armed Forces Radiobiology Research Institute, Defense Nuclear Agency, Bethesda, Maryland. His research interests include biochemical indicators of disease and injury and immunological effects of radiation exposure.

Sydney R. Parker is a professor in the Electrical Engineering Department at the Naval Postgraduate School in Monterey. He is a member of the Engineering Education Accreditation Committee of the Engineers Council for Professional Development, the national accreditation board for professional engineering curricula at U.S. colleges and universities. His most recent research has been in the area of digital filters and signal processing.

Thomas W. Mossberg is a research associate in the Department of Physics at Columbia University, where in 1978 he received his doctorate in physics. His research interests center on the investigation of laser-induced coherent transient phenomena and their application to the study of spectroscopy and relaxation in both solids and gases.

Rudolph J. Marcus served 14 years at ONR Pasadena before becoming Scientific Director of ONR Tokyo in March 1979. Special areas of concern during that time were photochemistry-photophysics and computer control of chemical experimentation. Dr. Marcus served as founding secretary of the American Chemical Society's Division of Computers in Chemistry (1974-79). His papers on photochemical energy conversion in the 1950's are still being cited.

Leon H. Fisher recently joined the staff of ONR Tokyo and is on leave from California State University,

Hayward. He recently completed an eight year assignment as Dean of Sciences at Hayward where he is also Professor of Physics. He has held professorships at New York University and at the University of Illinois. He has led research groups at the Lockheed Palo Alto Research Laboratory and the General Telephone and Electronics Laboratory. He has been visiting professor at the University of California, Berkely, the University of Washington, and the University of Southern California. His specialty is gaseous electronics, and his interests include ionization coefficients in gases, mechanism of electrical breakdown in gases, formation of negative ions, corona discharges, and plasma physics. He recently has coauthored articles on contact potentials.

Harley J. Walker is a Boyd Professor in the Department of Geography and Anthropology at Louisiana State University. He just completed a nine-month visit as a Japan Foundation guest professor at Tsukuba University. His interests lie in the areas of arctic hydrology, coastal morphology, and coastal defense systems.

Seikoh Sakiyama, Scientific Affairs Specialist of ONR Tokyo, has had considerable industrial experience in laboratory chemistry, electronic instrumentation, and quality control methodology. His interests include computer science, linguistics, and energy technology.

CONTENTS

Cover: A brush painting (sumi-e) of bamboo by Mrs. Sarah Gruner, a member of the American Embassy, Tokyo, community.

INDIAN NATIONAL INSTITUTE OF OCEANOGRAPHY

Francis A. Richards

The National Institute of Oceanography (N.I.O.) evolved from the activities of the International Indian Ocean Expedition (IIOE) and the plankton sorting center established at Cochin, for plankton samples taken during the expedition. The increasing importance of oceanography to India soon afterward became evident to the Indian government, and, in 1966, N.I.O. was formed. Originally, the institute was located in New Delhi, but, after a search for a suitable site, Dona Paula, a small town in Goa, the former Portugese colony on the central west Indian coast, was selected. The choice was a fortunate one, because of the variety of marine and estuarine environments that are readily accessible, and because of its central location on the Arabian Sea coast. The place is not easily reached from the population centers, and, although Goa's famous beaches are popular with tourists, Dona Paula provides a quiet ambience that the scientists find conducive to undistracted research. In 1969 the institute was transferred to Goa on a peninsula between the mouths of the Mandovi and Zuari rivers.

The institute now occupies an attractive building with about 10,000 square meters of floor space. There is also a hotel that can accommodate about 40 people, and there are staff quarters for many of the permanent personnel. The physical plant will be significantly enlarged in the near future.

The director of the institute is Dr. S. Z. Qasim, a biological oceanographer, and a physical oceanographer, Dr. V. V. R. Varadachari, is his deputy. The general objective of the institute is to build up competence in using the sea for the benefit of the Indian people. This is to be accomplished by oriented and unrestricted research in all aspects of oceanography. The benefits to be expected as a result of research include the exploitation of living and non-living resources of the sea, coastal defense, coastal services, coastal development, offshore engineering works, and pollution control. The institute also wants to develop self-sufficiency in marine instrumentation and to be the focal point for oceanographic data and information services pertaining to the Indian Ocean.

With the above objectives, it is to be expected that much of the work at the institute is of an applied nature, especially applications to national needs. A large fraction of the applied research is sponsored by various governmental agencies, boards and commissions, and by private industry.

The institute has seven divisions: physical oceanography, chemical oceanography, biological oceanography, geological and geophysical oceanography, marine instrumentation, ocean engineering, and a data and planning division.

The staff of the institute includes over 135 scientists, of whom around 30 are at the Ph.D. or D.Sc. level. About one-third of these have their degrees from foreign universities. There are around 170 technicians and nearly 100 in various administration positions. In addition to the parent institute at Goa, there are regional centers in Cochin (the old plankton sorting center), Bombay, and Waltair.

The institute operates one major research vessel, *Gaveshani*; there are three boats and four fiberglass dinghies. The motor launch, M.F.V. *Tarini*, is 15 meters long, the M.F.V. *Neendakara* is 12 meters long and aluminium hulled. The *Gaveshani* (from a Sanskrit word meaning researcher) was converted in Calcutta from a self-propelled hopper barge. Displacing 1900 tons, she is 68 meters long, has a 12.2-m beam, and draws 3 meters. Powered by two 840 B.H.P. engines, she has an endurance of about 25 days, cruises at 10 knots, and can accommodate 19 scientists and a crew of 45 officers and men. She is roll-stabilized by passive anti-roll tanks, and has airconditioned living spaces and laboratories (except for wet and biological laboratories). The laboratories have a total floor space of 134 square meters and provide working facilities for all branches of oceanography.

Laboratory equipment includes spectrophotometer, fluorometer, centrifuge, salinometer, and a G.-M. counter. The scientific equipment for data collection includes a sound velocity meter, STD (salinity-temperature-depth) and CTD (conductivity-temperature-depth) systems, and water, plankton, and sediment samplers. She has two hydrographic winches (2.5 tons, with 4000 meter of 4-mm-diameter wire), an hydraulic winch (5 tons with two 900-m lengths of 14-mm-diameter wire), a coring winch with 2000 meters of 8-mm-diameter wire, and a bathythermograph winch with 1000 meters of 4-mm-diameter wire. Her navigational equipment includes a CMA722A Canadian Marconi satellite navigation system.

RESEARCH ACTIVITIES

PHYSICAL OCEANOGRAPHY

There are three major areas of activity in physical oceanography: land-sea interaction, ocean-atmosphere interaction, and studies of storm surges. The land-sea interaction studies are vital to coastal-zone management, beach erosion problems, harbor sedimentation work, estuarine dynamics, and understanding currents and nearshore environments. Beach studies have been carried out around Cochin. The research is becoming more and more applied to the problems of coastal industries, hotels, and recreation centers; and more and more of the work is being sponsored by industry and other government agencies. Recent projects have included monitoring beaches and bays to document beach movements, siltation, erosion, and the interactions of currents with the shore and the bottom.

The physical oceanographers have participated in the MONSOON 77 and MONEX 79 studies. The MONSOON participation consisted of the analysis of BT (bathythermograph) data collected on board Russian research vessels during the 1977 program. The MONEX 79 participation includes four cruises of the *Gaveshani* into the Arabian Sea and two into the Bay of Bengal, making radiosonic observations of temperature, pressure, humidity, and wind at different levels in the atmosphere, and, in the water, temperature and salinity observations at different levels using Nansen bottle casts, bathythermographs (both mechanical and expendable) CTD casts, etc. Some chemical determinations are made on the Nansen bottle samples. Cruises were made in the Arabian Sea in May and July, and in the Bay of Bengal in July, 1979, in cooperation with U.S. aircraft. The MONEX observations included determinations of phosphate, nitrate, dissolved oxygen, pH, and occasionally nitrite and time series (week long) while the ship drifted in the Bay of Bengal. Storm surge studies are part of the general studies of physical processes in the seas surrounding India, which incorporate observations of temperature and salinity distributions, currents, water mass, sound propagation and light penetration.

Although theoretical physical oceanography is not a major effort of the physical oceanography group, its wind-induced circulation in the northwestern Indian Ocean has been derived from solutions of a vertically integrated vorticity equation relating planetary vorticity, lateral stress curl, and the curl of the stress exerted by the winds on the sea surface. Using a triangular basin model, the solutions accounted for many of the gross, and a few of the detailed, features of the monsoonal circulation.

CHEMICAL OCEANOGRAPHY

There are three main themes of research in chemical oceanography: chemical studies of the coastal and offshore waters in the Arabian Sea and the Bay of Bengal; protection of the marine environment and monitoring of pollutants; and drugs from the sea.

The general chemical studies embrace several of the classical concerns of chemical oceanography, but they are motivated by the possibility of exploitation of the oceans as an "inexhaustible source for food and minerals . . ." The investigations are aimed at describing the spatial and temporal distributions of biologically mediated constituents of seawater such as phosphorus and nitrogen compounds; biologically active trace metals such as iron manganese, zinc and cobalt; dissolved oxygen; and the carbon dioxide components. Other chemical problems under investigation are the arsenic cycle in coastal and offshore waters; the silicon cycle in estuaries and seawater; calcium phosphate and calcium sulfate saturation and precipitation; major constituents and chemical

speciation of important metals; the regeneration of nutrients in marine and estuarine environments in the sea; organic constituents of seawater; and desalination of seawater. Dr. C. G. V. Reddy is in charge of this program and of the drugs from the sea work.

The drugs from the sea project is a coordinated all-India endeavor in which N.I.O., the Central Drug Institute at Lucknow, the National Chemical Laboratory at Poona, and various universities and institutes are collaborating. The object is to develop new drugs and drug intermediates from living marine organisms. The steps in the investigation are:

1) collection of specimens of marine organisms and preparing extracts from them,
2) screening of the extracts for biological activity,
3) isolation of the active components of the drugs and elucidating their chemical structures, and
4) the synthesis of structural analogs of the active constituents and testing them for biological activity.

The extraction procedure is rather simple; the organisms are extracted with 90% methyl alcohol and the extracts are concentrated by evaporation under vacuum. The alcohol extraction is followed by a water extraction. This is carried out at N.I.O. The extracts are then sent to the central drug institute for testing for pharmacological properties. They are tested for effects on the central nervous system (CNS), the cardiovascular system (CVS), for antiviral, antibacterial, antibiotic, antifertility, antitumor, and antifungal properties (so far, no method exists for testing for anticarcinogenic function). Extracts of 80 species of seaweeds, mangroves, and marine animals have been tested; of these, 25 have effective antifertility properties, and extracts of some mangroves are effective analgesics.

A proposal for collaborative research with the Stevens Institute of Technology (New Jersey), the Osborn Laboratory of Marine Sciences (New York) and the Central Drug Research Institute (Lucknow) has been submitted to the National Science Foundation, to be supported by Public Law 480 funds.

There are five principal parts of Dr. Robin Sen Gupta's program on protection of the marine environment and pollutant monitoring:

1) monitoring of petroleum hydrocarbons in the marine environment;
2) monitoring toxic and non-toxic heavy metals and metalloids in seawater and marine organisms;
3) monitoring organochlorine and organophosphorus pesticides;
4) participation in MAPMOPP (Marine Pollution (petroleum) Monitoring Pilot Project) program of IGOSS (Integrated Global Ocean Station System) and GIPME (Global Investigation of Pollution in the Marine Environment), for which Dr. Sen Gupta is coordinator for the Indian Ocean region. (See *Scientific Bulletin 3*, No. 2, p. 28, for a description of Japan's activity in this program); and
5) various sponsored projects in both the private and public sector giving assistance and advice on problems of disposal of sewage and industrial effluents.

The monitoring of petroleum hydrocarbons is an institutional project for following total and aromatic hydrocarbons in seawater, sediments, and plankton. The water column is sampled at the surface, and at 10, 20, and 30 meters depth. Particular care must be taken to avoid contamination during sampling; surface samples are taken with a stainless steel bucket while the ship is still underway, and the subsurface samples are taken in glass-lined samplers. The samples (400 ml) are extracted on shipboard with 10 milliliters of hexane. They are later dried over anhydrous sodium sulfate and passed through a column of 40- to 60-mesh silica gel. The ultraviolet spectra (190 to 350 micrometers) are then determined using a Beckman Acta CIII spectrophotometer. Surface (neuston) tows are made for 15 minutes on each station sampled. Extracts of plankton and sediment samples (taken only at coastal stations) are cleaned by chromatography through silica gel, alumina, and metallic copper (to remove sulfur); the spectra are compared with that of Arabian crude oil. Hydocarbons of varying carbon chain lengths are differentiated by gas chromatography. The MAPMOPP sampling program is along the main oil tanker lanes across the Arabian Sea and the Bay of Bengal; about 50% of the world's petroleum transport is across the Arabian Sea.

An interesting investigation by Dr. Sen Gupta concerns the differentiation of biogenic, in contrast to fossil, hydrocarbons in seawater extracts. Extracts of hydrocarbon-containing seawater in redistilled normal hexane generally show a spectrophotometric peak at 256 micrometers; the peak generally disappears after a clean-up step of chromatography on silica Gel. Sen Gupta believes that the disappearance of the 256 μm peak is proportional to the biogenic organic compounds in the sample. His hypothesis has been checked by infrared spectrophotometry before and after silica gel chromatography. He now wants to examine gas chromatographs of extracts before and after silica gel chromatography.

An adjunct to the petroleum hydrocarbon pollution study is a laboratory project to investigate the oil removal properties of polyurethane foam and various dispersants.

A somewhat surprising activity in the chemical oceanography group is an investigation of the increase in heat absorption by water upon the application of various materials on the surface. It is part of a project for desalination of seawater using solar energy. Various black pigments have been tested: black enamel paint, blackboard paint, graphite, charcoal, lampblack, sawdust, and a mixture of lampblack and sawdust. The lampblack and sawdust mixture was 23% better than black paint alone and had the advantage of dispersing evenly over the surface of the water.

The chemical oceanography laboratories appeared to be well equipped and, in spite of the attempt to produce their own instrumentation, most of the instruments have had to be imported. They do have a mercury analyzer made by the Bombay Atomic Energy Establishment that works on the principle of stannous chloride reacting with cold vapor. Other instruments in the laboratory are: Hilger and Watts Atomspek HI550; Bausch and Lomb Spectronic 88 spectrophotometer, good in the 380-1000 micrometer range and used at sea; the Beckman Acta CIII spectrophotometer mentioned earlier; a Hilger and Watts Infragraph H-1200 infrared spectrophotometer; a Turner fluorometer (a Turner spectrofluorometer was on order); an Orion specific ion analyzer (to be used for calcium and sulfate ions in a study of gypsum equilibria; this is of interest because gypsum is formed in salt pans during the production of solar salt and sometimes gypsum crystals are found in coastal sediments); a photometric titrator used for calcium and magnesium determinations using EGTA [(Ethylenebis (oxyethylenenitrilo) tetraacetic acid)] which forms a complex with calcium but not with magnesium; a Guideline Autosal inductive salinometer; an SP 8000 liquid chromatograph, and x-ray diffraction equipment used for geological studies, and an automatic titrator for dissolved oxygen determinations.

GEOLOGICAL OCEANOGRAPHY

The geological oceanography group is headed by Mr. H. N. Siddiquie, and contains geologists, geophysicists, geochemists, sedimentologists, micropaleontologists, and marine surveyors. They are involved in five major projects: the geology and structure of the continental margins of India; the sediments of the continental margins; the geochemistry of sediments; and a newly-initiated investigation of manganese nodules in the Indian Ocean. In addition, the group does a lot of work for industry, mostly the Oil and Gas Commission (a government company). A major sponsored program was a pipeline survey from the Bombay High oil field to shore. Several routes had been proposed by the oil and gas commission and the N.I.O. was engaged to survey the routes to select the best one. Geological and geophysical investigations included bathymetry, seismic profiling, and bottom geology. The seismic profiling is confined to the upper 500-100 meters; the oil and gas commission does the deeper work. Sound sources are a speaker and a boomer. Geological sampling is by grab, cover, and dredge. Side-scan sonar is used in the bathymetric work. Another pipeline survey has been completed between the Bassein oil field and Gujarat. The pipeline surveys have been particularly advantageous to the institute, permitting them to build up their expertise, experience, equipment, and reputations.

The geological and structural survey of the Indian continental margin encompasses cruise tracks normal to the coast, every 20 kilometers out to the 2000-meter contour. The observations include continuous echo soundings, side-scan sonar, and shallow-water seismic profiling. Bottom sampling with corers, grabs, and dredges are taken every 10 kilometers. In September, 1979, the survey had been completed from Bombay to Cochin.

Part of the continental-shelf survey work is a geochemical program to describe the distribution patterns of sediments on a bulk-sample basis, followed by the distributional patterns of different components of the sediments, and then a study of the processes of incorporation of the various elements into the sediments. The general sedimentological framework and grain size parameters are supplied by the sedimentologists.

The bulk sample analysis gives simply the total elementary composition of the samples. The samples are then leached with 10% acetic acid, which removes all the elements adsorbed and those present as carbonates. The residue is treated with acetic acid and hydroxylamine hydrochloride, which leaches out the elements associated with iron and manganese oxides. The next leach is with hot 50% hydrochloric acid, which removes the elements associated with the intercrystalline structure of the clays. The residue contains resistant elements (needless to say). A separate sample is treated by Kaplan's procedure, the initial step of which is extraction with 0.1 normal sodium hydroxide under nitrogen to recover organic matter including humic and fulvic acids.

Geochemical studies have now been completed on the distribution of calcium carbonate, iron, manganese, titanium, phosphate, alumina, nickel, cobalt, copper, zinc, and organic carbon from the Karachi Coast to Goa.

From the beach to a water depth of a few meters the sediments are characterized by terrigenous silts and clays of recent origin. Seaward, the sediments are characterized by aragonite and are relict. The concentrations of all constituents except phosphate and calcium and strontium carbonates are higher inshore, while the phosphate and carbonates increase away from the coast.

The seasonal upwelling along the Arabian Sea coast of India may be almost as high as that off Peru, resulting in primary production (photosynthetic production) rates of up to one gram of carbon per square meter per day. There is a well-developed, oxygen-minimum zone at about 200 meters depth and, where this minimum impinges upon the bottom, the sediments contain up to 6 or 7% organic matter—3-3.5% organic carbon. Apparently, the phosphate, released in the interstitial waters of the sediments, replaces carbonates, a process that could account for the formation of phosphorites. It has been reported that the upwelling process began in the Miocene, but DSDP (Deep-Sea Drilling Project) results indicate that it began during the Eocene.

A process that may lead to direct correlation between ferric oxide (Fe_2O_3), managanese dioxide (MnO_2), and other elements such as nickel, cobalt, and zinc may be their coprecipitation with iron and manganese colloids formed in the river systems, although these elements may be diluted in the nearshore sediments by other terrigenous materials.

The sedimentologists have prepared sediment distribution maps of about 75% of the western Indian continental shelf in water depths between 200 and 1000 meters. In water depths of up to 50 meters, the sediments are fine, mostly clays. At greater depth, the sediments are mostly calcareous sands; in the northern part of the region there is a high percentage of oolites. These have carbon-14 dates of 8,000 to 11,000 years before the present; they have two or three layers of "cortex" and a nucleus that is large in comparison with the cortex. The oolites are primarily aragonite with little organic matter or calcite.

The carbonate mineralogy of the shelf sediments is being worked from the northern, west Indian shelf southward; most of the laboratory work has been done and the data await processing.

The micropaleontologists are investigating both the living and dead foraminifera on the continental shelf. On the beaches, there are distinctly different faunal zones on the east and west Indian coasts. It has also been found that the benthic foraminifera are sensitive indicators of environmental stresses, specifically pollution. Some typical areas have been selected for pollution studies; one is the Cola Bay region, where it has been found that the total number of foraminifera in a gram of sediments is inversely proportional to the organic content of the sediment. In the Thana Creek are near Bombay, there are no living benthic foraminifera, but there are corroded and pitted dead forms, caused by acidic effects of various kinds of industrial pollution. The group is preparing charts of foraminiferal distributions for the entire area. Similar studies are being carried out for the nannoplankton organisms of the region.

A project of the geological oceanographers has been the exploration of ilmenite placers of the Konkan coast. This region has many small bays containing ilmenite (Fe_2TiO_3) and magnetite. The group has investigated the chemical mineralogy and hydrodynamic conditions leading to the ilmenite-rich sand-size silts and sediments. The bays are typically about 5 by 10 kilometers; some 4590 sediment samples have been collected from three of the bays (Ratnagiri, Kalbadevi, and Mirya). The heavy mineral placers in these bays, based on analysis of some 450 samples, extend 2-5 kilometers offshore to depths of 9-12 meters. The heavy minerals in the sediments range from 1-91%, with ilmenite from 2-52%. It is estimated that the ilmenite resources of these bays is about 2×10^6 tons.

BIOLOGICAL OCEANOGRAPHY

A highlight of my visit to N.I.O. was the renewal of an old acquaintance with Dr. T. S. F. Rao, with whom I had sailed on an oceanographic cruise out of Woods Hole Oceanographic Institution on the original *Atlantis* some 20 years earlier. He, Dr. Qasim (the director of the institute), and Dr. K. Radhakrishna lead the programs in biological oceanography of the institute. These are, in broad terms, a survey of the biological resources of the seas around India; coastal aquaculture; and biogeographical, ecological, and experimental studies on phytoplankton and zooplankton from the Indian Ocean. The survey of biological resources includes assessments of primary and secondary productivity, extracellular, detrital, and benthic production, biochemical investigations, mangrove ecology and bloom, and microbiological studies. Within the program are two institutional projects: studies of the biological productivity of the Indian Ocean and the microbiology of different ecosystems, including backwaters, estuaries, mangrove swamps, sandy beaches, continental islands, coral reefs and atolls, and neritic, nearshore, and oceanic regions. The primary productivity studies include assessments of the rate of photosynthetic production using the carbon-14 fixation method, studies of phytoplankton ecology extracellular products, and all living aspects of primary production. At the secondary productivity level, the production and qualitative and quantitative distributions of zooplankton organisms in different ecosystems are assessed and monitored. Benthic organisms play an important role in the food chain, and play an important part in the survey of biological resources. The productivity of the benthos and the ecology and distribution of the meiobenthos are important to an assessment of the fisheries resources of the country. Similarly, the role of bacteria in the food chain as food sources and as agents for the biodegradation and recycling of nutrient elements must be understood to evaluate the biological resources of an ecosystem.

Studies of benthic population were started in the estuaries in and around Goa. Since around 1973, the institute has conducted 28 cruises for the study of benthos out from the coast to water depths of 2700 meters, quantifying the benthos as part of the food web. The benthic organisms have also been studied in relation to pollution stresses, particularly stresses brought about by sewage and industrial wastes. The group is participating in the so-called mussel watch, an international program of monitoring heavy metal accumulation by mussels, which are almost ubiquitous and good indicators of a group of metals in the environment in which they live.

Dr. Rao is a zooplankton specialist especially interested in chaetognaths, zooplankton productivity, and estuarine studies. He is now trying to assess the productivity of various trophic levels in the water column to evaluate the transfer of energy from trophic level to trophic level. His aim is to develop a good model for these energy transfers. In addition to the studies of the water column energy cycle, there are groups working on energy transfer in seaweeds, mangroves, the benthos, and in extracellular products of photosynthetic activity.

All of the biological oceanography groups contribute basic information to the aquaculture project, under the general direction of Dr. Qasim. In India, the important organisms for acquaculture are bivalves (mussels, clams, and oysters), seaweeds, and shrimp (these are the organisms being studied at N.I.O. I visited none of the fisheries research establishments, and fin fish may be important in the aquaculture activities in the country but they are neglected in this report.)

The aquaculture group has researched methods for the culture of the green mussel *Mydilus viridius*. They have devised a method of culture on ropes suspended from floating rafts, a method now being used in commercial production. The oyster *Crassostrea gryphoides* is also being cultured commercially. The main

aquaculture work is on estuarine bivalves such as brown mussels, six or seven species of edible oysters, and a variety of clams. Pearl oysters have a spotty distribution along the Indian coast, but a stenohaline species is now being cultivated; nuclei for pearl production are being produced from the shells of a large local gastropod. The nuclei have a smaller rejection rate than other materials (the Japanese cultured-pearl industry uses nuclei cut from a Mississippi River freshwater clam).

The N.I.O. is investigating seaweed culture–especially the *Laminaria* species grown for the production of agar. However, most of the Indian coastline is not particularly good for seaweed growth; it is generally smooth with few rocky regions; the algae suffer from the high winds and waves of the monsoon seasons. Other aspects of aquaculture seem more promising. There is a project to investigate the mass culture of certain algae (*Tetraselmis gracilis*, among others) using diluted sewage as a nutrient source. *Ulva* and *Porphyra* species have also been investigated to determine their growth characteristics and tolerance to sewage pollution. The question is important; there are some 25 species of macroalgae along the Goan coast and about 1300 species along the whole of the Indian coast. The commercial importance of these plants could be substantial. Investigations of the effects of seaward extracts on various plants (as fertilizers) indicate good results on the growth of maize and beans without added phosphorus or nitrogen.

A recurring theme in southeast Asia, New Zealand, Australia, and India is the ecological importance of mangroves and mangrove swamps. The subject is not being neglected at N.I.O. Along the Goan coast alone, there are about 2000 hectares of fringing mangroves; it is estimated that there are 3.5 million hectares of these ecosystems in India. Their exact extent is difficult (or impossible) to estimate and characterize. LANDSAT photographs are often obscured by cloud cover and are difficult to interpret–there are no standard methods for interpreting satellite photographs of mangrove swamps. Nonetheless, these ecosystems are very important in the culture of fish and shrimp. The problem is exacerbated by the exploitation of the mangroves. The trees are being cut for firewood and other uses (such as tanbark for leather processing); there are neither laws nor regulations to protect the mangroves; as a consequence, the swamps are producing smaller and smaller trees with significant degradation of the swamp ecology. The N.I.O. is attempting to provide a scientific basis for decisions for the management of these important environments.

The work of the institute on aquaculture is based on fundamental concepts of biological transfers of energy–the term bioenergetics is used. The aquaculture group focuses on questions of energy requirements of fishes, prawns, and seaweeds. This work entails surveying the caloric content of commercially important species and their nutritional aspects. On the Goan coast, the commercially important species are fishes, prawns, and mussels–these have the maximum caloric content. The group at N.I.O. is concerned with which foods give the best caloric content and with which foods give the best growth in the shortest time. The aquaculture group is trying to establish not only which foods give a cultured population the most growth in a given time, but also the energy flow along trophic levels in natural and artificial environments to determine the most efficient pathways. The group wants to extend their experiments to the field to test their laboratory findings in large-scale aquaculture projects.

The national salt company is sponsoring a project on the culture of the brine shrimp *Artemia Salina*. Newly hatched brine shrimp are an important food for cultured shrimp larvae. Although there have been attempts to use other foods such as yeasts, there remains significant demand for brine shrimp eggs from Great Salt Lake in the United States. In 1979 the price for the eggs was about $75 per kilogram. Research at the N.I.O. has resulted in the production of up to 10 kilogram of brine shrimp eggs from one acre of salt pans. The female shrimps release 50-60 eggs every other day for a period of 75-80 days. The energy available to the larvae prawns is highest immediately after the brine shrimp hatch, when the animals contain about 60% protein. It has been found that the brine shrimp eggs can be decapsulated by treating them with sodium hypochlorite; such decapsulated eggs are 100% viable and can be stored in highly saline water for years. Upon dilution of the saline solution to a salinity nearing that of seawater (3.5% salt), the eggs will hatch and the animals will be available to feed the shrimp larvae.

Dr. A. Rajendran is using diatom cultures for bioassays for vitamin B_{12}. He has been using culture of the

diatom *Cyclotella nana* from the laboratory of Dr. O. Holm-Hansen of Scripps Institution of Oceanography. Dr. Rajendran has been trying to find a local diatom species to use in the bioassay, and, although he could not keep most of them in culture, *Skeletonema costatum* appears to be a suitable organism for the bioassay.

Dr. Aditi Pant, who was a student of Dr. E. G. Fogg of the Marine Research Laboratories, Menai Bridge, U.K., is investigating the products released by phytoplankton organisms during photosynthesis. She supplies the phytoplankton with radiocarbon-labeled sodium bicarbonate and, after an incubation period of four to six hours, filters off the particulate matter. The filtered material is then acidified to permit the replacement of the carbon-14 carbonate with stable carbon-12 carbon dioxide from the air; this leaves the organically-bound carbon-14 behind, and permits the estimation of the fraction of the total carbon dioxide taken up and incorporated in the phytoplankton cells or released in organic extracellular products. Her techniques can be used to examine relationships among light, nutrient deficiencies, chlorophyll content, and photosynthetic carbon fixation. She then wishes to characterize these relationships biochemically using biochemical methodology.

OCEANOGRAPHIC INSTRUMENTATION

India is faced with a shortage of foreign exchange and, consequently, with a requirement to produce, domestically, oceanographic instruments that might well be more efficiently manufactured in other countries. On the brighter side, the time, energy, and talent devoted to producing their own instruments can lead to basic improvements and to instruments specifically tailored to their local needs. An example is the requirement for a good shallow-water wide-range salinometer, demanded by the complex estuary system of the Goan coast.

The instrumentation laboratories of the N.I.O. have been developing and producing instruments for the observation of several oceanographic variables, such as salinity, temperature, and currents. They have been working to develop a variety of temperature sensors and electromagnetic- and rotor-type current meters. A rotor-type current meter for use from anchored ship has been designed; with a plastic rotor, it is useful to depths of about 40 meters; with metal rotors, the instruments are good to about 200 meters. The Indians must still import some of their components, for example, underwater cables and compasses, although the necessary cable connectors are now produced locally.

The instrumentation laboratory has developed a shallow-water echo sounder that can be used in the inverted mode as a wave height indicator. It is useful to depths of about 30 meters and thus is suitable mostly for river and estuarine observations. The echo sounder can be used to detect depths to within about five centimeters, and the detection of wave height should be of about the same accuracy. The instrument gives a digital readout in meters or centimeters. It is battery-operated, small, compact, portable, and can be used from a small canoe. It has ultrasonic sending and receiving transducers operating on 150 kilohertz impulses. It has the advantage of giving direct depth (or wave height) readings instantly at any place in the river. The all-integrated circuits include no transistors, and most of the components can be bought in India, except for the pulse transformers; these are being manufactured in the laboratory in Goa. The instrument has been tested with good results against simultaneous observations with a wave and tide gauge that uses a sensitive pressure sensor.

The instrumentation unit has mechanical and electronic shops that can do minor repairs and trouble shooting. The group is now designing its own CTD (conductivity-temperature-depth) recorder, although in the past they have imported Guideline instruments from Canada.

PLANNING, PUBLICATIONS, INFORMATION, AND DATA DIVISION

There are four distinct areas in which this division works; management of oceanographic data; management of oceanographic information; publications; and project planning, monitoring, evaluation, and costing.

The Indian National Oceanographic Data Center (I.N.O.D.C.) has a data bank from over 11,000 oceanographic stations occupied in the Indian Ocean by 50 research vessels from 15 countries. They continue to receive data from the World Oceanographic Data Centres as well as from Indian researchers. They have available

for their users:

1) I.N.O.D.C. Data Catalogue, a reference to all the data they have available;
2) data on computer listings, punched cards, and magnetic tape for computer time and handling charges;
3) oceanographic data charts containing existing data from the exclusive economic zone of India (the first series of charts on the sea off Gujarat is complete and available for distribution);
4) an annual I.N.O.D.C. newsletter, which now covers only the cruises of *Gaveshani*; and
5) computer-oriented data processing services, also available for processing work of scientific and commercial sources on a no-profit no-loss basis.

Computer courses on FORTRAN IV and COBOL are given from time to time. In addition, the center keeps in touch with the activities of the IOC Working Committee for International Oceanographic Data Exchange. It also works as an input center to the marine environmental data information referral system.

The center has prepared the following documents, which are available to many users:

1) Information Resources in Marine Science in India;
2) Indian National Directory of Marine Scientists; (The 1978 directory gives information on the specialties and affiliations of 714 marine scientists and technologists working in 72 marine-based institutions. It provides the Indian input to the World Directory of Marine Scientists published by FAO (Food and Agriculture Organization of the United Nations). It is computerized and is to be revised and up-dated every two years.)
3) Indian National Directory of Marine Research Projects–a computerized listing will be issued;
4) Indian National Directory of Training and Education in Marine Sciences;
5) Various brochures and pamphlets about the activities and facilities of the institute;
6) Selected bibliographies on specialized subjects;
7) Collated reprints, sent world-wide on an exchange basis; and
8) Press releases.

The institute publishes *Mahasagar*–Quarterly Bulletin of the National Institute of Oceanography. This carries original research papers, review articles, short communications, and book reviews. The division also publishes an annual report, cruise reports (over 50 have been published) and a quarterly N.I.O. newsletter.

OCEAN ENGINEERING

An Ocean Engineering Section is involved in coastal engineering studies applicable to rural development and in the development of offshore engineering and technology for the utilization of coastal resources.

INTERNATIONAL ACTIVITIES

N.I.O. is involved in several international projects. One, recently completed, was the preparation and publication (by the United Nations Environment Programme, UNEP) of a Directory of Indian Ocean Marine Research Centres. The work of Dr. Robin Sen Gupta, the directory contains information on 78 institutions in 13 countries; 27 Indian institutions are listed.

In November 1978, the institute hosted an Indo-U.S. Workshop on Oceanography which considered the interaction between the monsoon and ocean circulation; factors influencing biological productivity in the northern Indian Ocean; sources, fluxes and fates of materials entering the seas around India; and marine geoscientific studies of the Indian margins and plate tectonics phenomena. The American coordinator was Roger Revelle, and there were 13 other American participants and 37 Indian participants. The proceedings have been published by the Ocean Science and Technology Agency.

As part of India's participation in the MAPMOPP program of IGOSS, observations from *Gaveshani* of oil

spills and other floating pollutants, of particulate petroleum residues, and of dissolved and dispersed hydrocarbons are carried out.

The institute is participating in the program of the International Foundation for Science, Stockholm, program on aquaculture of mussels, oysters, and prawns, using treated domestic sewage. A series of experiments to determine the best mixture of sewage and seawater to get the maximum quantity of phytoplankton has been completed.

The staff members of the institute publish widely in national and international scientific journals, contributing importantly to the *Indian Journal of Marine Sciences*, a multidisciplinary quarterly published by the Publications and Information Directorate of CSIR, Hillside Road, New Delhi 110012, India.

APPENDIX

National Institute of Oceanography
P. O. Dona Paula
Goa-Pin 405004, India

	Specialty
– Dr. S. Z. Qasim, Director	Biological oceanography
Dr. V. V. R. Varadachari, Deputy Director	Physical oceanography
– Dr. C. G. V. Reddy (heads chemical oceanography program)	Chemical oceanography
– Dr. Robin Sen Gupta	Chemical oceanography
– Mr. H. N. Siddiquie (heads geological oceanography program)	Geological oceanography
– Dr. T. S. F. Rao	Biological oceanography (zooplankton)
– Dr. K. Radhakrishna	Biological oceanography
– Dr. A. Rajendran	Biological oceanography
– Dr. Aditi Pant	Biological oceanography

OCEAN SCIENCE AND TECHNOLOGY AGENCY DEPARTMENT OF SCIENCE AND TECHNOLOGY GOVERNMENT OF INDIA

Francis A. Richards

The many and varied interests in marine affairs of the Indian Government are reflected in marine activities in many governmental ministries and agencies as well as in universities. The concern of the Ministry of Food, Agriculture, and Marine Fisheries is obvious. India is desperately short of oil and natural gas, and the Ministry of Petroleum requires detailed geophysical exploration for and exploitation of hydrocarbon resources, especially on the Indian continental shelf. An arm of the Ministry of Petroleum is the Institute of Petroleum Exploration, which has its own facilities for geophysical research.

Within the Ministry of Steel and Mines, the department of mines is charged with the development of mineral resources, including the mineral assets of the continental shelf. The department of energy development is looking to wave and total energy sources and to ocean thermal energy conversion (OTEC). The Ministry of Civil Aviation and Transport is concerned with meteorology, which in turn is closely related to the problems of water resources, as well as shipping and transport in the coastal zone and its marine environment. The Ministry realizes the coastal marine environment needs to be better understood to avoid the deleterious effects of major port cities, beach erosion, and cyclones, which occur on the east coast of India in October and November.

The hydrographic survey must perform the usual bathymetric surveying, and the central water and power research station is responsible for a wide variety of problems from the planning and construction of dams to tidal energy development. In addition, there are the teaching and research activities in marine science at the teaching institutions.

Without some central authority and coordinating body, the governmental marine activities could approach chaos. To serve this function, the Ocean Science and Technology Agency (OSTA) has been formed within the CSIR (Committee for Scientific and Industrial Research),[1] an autonomous agency under the department of science and technology. The director of OSTA is Commander Narindra Singh, a dynamic personality who is well versed in the historical developments of oceanography in India, especially the international Indian ocean expedition. During that expedition, a center for sorting plankton samples was established at Cochin—Cochin Marine Biological Center, and the National Institute of Oceanography grew out of that biological center.

OSTA is a planning and coordinating body, it is a funding agency, and it acquires facilities for multidisciplinary and integrated marine research. Thus, it has some of the features of the Office of Naval Research, the National Science Foundation, and the National Oceanic and Atmospheric Administration. It also is assuming the responsibility for data management and information exchange. Its basic purpose is to assist the many ministries and agencies with marine interests.

---

[1] The Indian Council for Scientific and Industrial Research appears to be patterned somewhat like the corresponding establishments in the United Kingdom, Australia, New Zealand, and South Africa, among others. The various laboratories, institutes, associations, and organizations cover physical and earth sciences, chemical sciences, biological sciences, engineering sciences, information sciences, and industrial research associations (fiber science and technology, biological and engineering science associations). Physical and earth sciences establishments are the national physical laboratory, New Delhi; the central electronics engineering research institute, Pilani; the central scientific instruments organization, Chandigarh; the national geophysical research institute, Hyderabad; and the national institute of oceanography in Panaji, Goa.

Broad policy for OSTA is promulgated by the OSTA Board, which meets annually and is chaired by the Prime Minister in his (or her) capacity of Minister of Science and Technology. More day-to-day matters are in the hands of a standing committee chaired by the secretary of the department of science and technology; the committee has representatives from a number of ministries, agencies, and the national institute of oceanography.

OSTA has taken its cue from the DOE (International Decade of Ocean Exploration of the National Science Foundation) for its working programs: non-living resources; meteorology, and physical and chemical oceanography; environmental quality assessment; coastal zone management; seabed assessment; data management and systems development; marine technical development; and manpower development, primarily a function of the universities.

Until now, the utilization of data, information exchange, manpower development, and marine research have been within government agencies rather than the universities. Commander Singh believes that 15 to 20% of the billets on research vessels should be allocated to teaching institutions, and that a scientist allocated one month at sea needs four to six months to work on the data. On the other hand, specialized hardware and high-grade technology and technicians are required to get good data, and Commander Singh feels this is the responsibility of OSTA, because the scientific agencies cannot provide the high-grade technology that is necessary.

A major current project of OSTA is the acquisition of a new oceanographic research vessel—specifically dedicated to the problems of non-living resources (it is subtly implicit that a ship for diving resources should follow). Negotiations for design specifications are now being carried out in West Germany, but general characteristics of the vessel have been defined: a vessel of about 3000 tons is required for dedicated meteorological observations during the monsoon season; she should provide a seagoing meteorological radar station (Commander Singh would like to have Doppler radar equipment); she should be equipped with geophysical equipment and geological tools. Initially, there will be a four- to six-channel air gun system, and a 24- to 48-channel system is a later objective. The vessel will be capable of physical and chemical oceanographic observations and sampling. During the monsoon season, she will be dedicated to meteorological observations and to geological and geophysical work the rest of the year. Biological observations may be carried out on a ship-of-opportunity, not-to-interfere basis. The vessel will carry 31 scientific and technical personnel, of which eight will be permanent OSTA technicians; the other billets will be reserved for the teaching institution. The ship will have a total complement of about 60 and will be operated by the Shipping Corporation, a government organization.

OSTA appears to have a well-conceived program that is taking advantage of the experiences of the more-developed countries. The immediate needs and practical applications essential to a developing country are guiding influences, but the needs for basic science are well understood and receiving proper attention.

ION BEAM ANALYSIS OF MATERIALS AND ION IMPLANTATION APPLICATIONS IN THE PEOPLE'S REPUBLIC OF CHINA

Eligius A. Wolicki

As a result of correspondence by Dr. James F. Ziegler of the IBM Research Laboratories in Yorktown Heights, New York, with Professor Tsou Shih-Chang of the Shanghai Institute of Metallurgy, invitations were extended to a group of four U.S. scientists to lecture in the People's Republic of China on the general subjects of: "The Analysis of Materials by Ion Beams and Nuclear Reactions" and "Ion Implantation Applications." Members of the group were: Dr. Ziegler, Professors James E. Mayer and Sylvanus Lau of the California Institute of Technology, Pasadena, and the author. Our group received invitations from the Shanghai Institute of Metallurgy, the Shanghai Institute of Nuclear Research, and the Chinese Academy of Sciences. The account which follows is my personal report of the events of the trip. A list of the organizations we visited and their research divisions and principal scientists is available upon request.

In general, Chinese scientists are very much up to date in their knowledge of research being conducted elsewhere in the world, but they are hampered in their own work by a shortage of good modern equipment. Despite this circumstance, I expect to see the Chinese make very substantial, and perhaps even surprising, progress in the next ten years in science and technology. My reasons for this opinion lie in the fact that the Chinese are now enthusiastically pursuing all avenues for advancing their research. They are concentrating on educating their students, they are making plans for the future which include major equipment purchases, they are inviting scientists to come to their country to work with them and to inform them about particular areas of science, they are sending scientific delegations to international conferences, and they are sending students and scientists to study and work in western countries.

On several occasions, our hosts expressed an interest both in having individual Chinese scientists come to the United States to work and in having scientists from the United States come to China to work. In the latter case, the minimum working period which would be considered worthwhile would be at least three months. The areas of interest to the laboratories we visited are ion implantation, both in metals and semiconductors; ion beam analysis of materials; construction and development of ion sources; design, construction, and development of accelerators; the growth and characterization of semiconductor crystals such as silicon and gallium arsenide; and the fabrication of devices both from silicon and from compound semiconductors. Anyone interested in the possibilities of working in China should feel free to write to me for the names of places and scientists who may be contacted in particular subject areas.

Our group entered China on Sunday, May 13, 1979, by taking a train from Hong Kong to the border. At that point we left the train and walked across a covered bridge over the Pearl River into the People's Republic of China and the town of Shum Chun. In Shum Chun, our arrival was already expected by the customs officials, and we received train tickets for travelling to Kwangchow (Canton) from two representatives of the Chinese Academy of Sciences. We proceeded from Kwangchow to Shanghai by air and were met upon arrival by Dr. Tsou Shih-Chang of the Shanghai Institute of Metallurgy, Dr. Cheng Hsiao-Wu of the Shanghai Institute of Nuclear Research, and by a number of other individuals. From the outset and throughout the trip, we were received everywhere with unusual hospitality and with great consideration for our interests and wishes.

As we were to learn subsequently, our first meeting with our hosts at the Shanghai Institute of Metallurgy followed a procedure which was standard for receiving visitors, whether it was at a factory, a farm commune, a university, or a research institute. We first were met, as we exited from our bus, by the director or deputy

director and several of his associates. We were next ushered into a receiving room, served hot tea, and welcomed by our host, who would, through an interpreter, proceed to give us details about the organization we visited. We were finally invited to respond and, particularly during our tour, to recommend any way we might see in which the operation of the organization could be improved.

SHANGHAI INSTITUTE OF METALLURGY

Thus, on Monday morning, we visited the Shanghai Institute of Metallurgy where we were met by Dr. Chou Yung-Chi, the director of research, by Dr. Tsou Shih-Chang, head of the Ion Implantation Division, and by Dr. Cheng Hsiao-Wu from the Shanghai Institute of Nuclear Research, and a number of other scientists from both institutes. Both institutes belong to the Chinese Academy of Sciences. We were informed that the Institute of Metallurgy employs approximately 1,100 people, of whom approximately 600 are technical. Dr. Chou received a Ph.D. in physics from the Carnegie Institute of Technology. The institute is composed of the following divisions: large scale integrated circuits, superconducting and magnetic materials, ion implantation, compound semiconductors, metal physics and semiconduction, metal corrosion, analytical chemistry, and electronics.

Among the laboratories or groups we visited were: a pilot production line for bipolar random-access memories; GaAs crystal-growing facility; a GaAs solar cell fabrication group that reported achieving 15% efficiency for a xenon lamp under an air mass = 1 condition; a facility for vapor phase GaAs epitaxy where work was being performed on Gunn, varactor, and switching diodes, photodiodes, and FETs; and a group working with a 200 kV ion accelerator that is performing both ion implantation experiments and Rutherford backscattering measurements on implanted samples.

In another laboratory, we saw a Q-switched ruby laser which was being used to perform laser-annealing experiments on samples of silicon into which bismuth had been implanted. Both Q-switched and CW laser-annealing studies had been performed. Rutherford backscattering and channeling experiments were performed to study the recrystallization and the diffusion of the bismuth following the laser anneals. Preliminary conclusions reached were that both Q-switched and CW laser annealing are superior to thermal annealing.

A new ion implantation accelerator is being acquired by the Institute of Metallurgy and will be built by the Shanghai Factory for Electrical Generators. Dr. Tsou, head of the ion implantation division, is using drawings of the Aarhus University 600-kV accelerator in Denmark and has been consulting with Professors Lindhard and Nielsen of that country. The new machine will have five beam lines, two of which will be used for ion-beam analysis and three of which will be used for ion implantation. The accelerator, expected to be finished by 1981, will be able to provide analyzed beams with atomic masses up to 200.

SHANGHAI INSTITUTE OF NUCLEAR RESEARCH

On Monday afternoon, after approximately a one-hour bus ride, we reached the Shanghai Institute of Nuclear Research, which is northwest of the center of the city. Upon arrival we were met by the deputy director of the institute, Dr. Chang Jia-Hwa, and by Dr. Cheng Hsiao-Wu. We learned that the institute had been established in 1959 and presently consists of 400 people. Two divisions were described to us, one being the application of nuclear techniques division, headed by Dr. Chang Jia-Hwa, and the other being the nuclear physics division, headed by Dr. Cheng Hsiao-Wu. Dr. Cheng studied at the University of Minnesota. The institute operates a 1.2-meter-diameter fixed-frequency cyclotron which can accelerate deuterons to 15.6 MeV and alpha particles to 31.6 MeV, a 120,000-curie cobalt source, a 200-kV neutron generator which has a source strength of approximately 10^{11} neutrons per second, and a 1.5-million-volt Van de Graaff accelerator.

This institute is beginning plans to convert the cyclotron to a sector focusing cyclotron which will have a proton energy variable from 10 to 30 MeV. We were particularly interested to learn that the institute is presently designing a new tandem Van de Graaff, which will be built in Shanghai and will have a terminal voltage of between 6 and 7.5 MeV. After a long period when no new students joined the institute, the situation is now improving, and the institute is beginning to receive some university graduates. A student graduating from the

university graduates. A student graduating from the university enters the institute as a research assistant. From there, he can advance to research associate, then to research associate professor, and finally to research professor.

In one of the laboratories visited, we saw a Mössbauer measurement which was being used to look at ^{119}Sn implanted into GaAs to a fluence of $5 \times 10^{14}/cm^2$ at 60 keV and then laser annealed. The Mössbauer results showed that, before annealing, the tin resides on four sites in the lattice, and that, after annealing, it resides only on a substitutional site. Again, as was the case for the bismuth implantation into silicon, laser annealing appears to be better than thermal annealing. We also saw one apparatus for measuring perturbed angular correlations and another for measuring positron annihilation lifetime in order to study defects in metals. The 300-picosecond time resolution presently obtained with the latter equipment is not yet adequate for the planned studies. The institute is fabricating some of its own solid-state electronic modules and is using the NIM-bin system, which is common in the U.S.

On Tuesday, May 15th, we began our series of lectures. On this day, each member of the group gave an overview of the subject material that would be discussed in greater detail on succeeding days. The audience for these overview lectures consisted of approximately 150 scientists who had come to Shanghai from a number of other cities in China. The lectures were given at a lecture center of the Chinese Academy of Sciences, which had a large number of lecture halls in it, and which was in heavy use by others during the time that we were there.

On Wednesday, the original audience of 150 was split into two approximately equal parts, one of which heard detailed lectures by Professors Mayer and Lau on ion implantation applications to semiconductors and on laser annealing, and the other of which heard lectures by Dr. Ziegler and by me on analysis of materials by backscattering and on nuclear reactions and ion implantation applications to metals.

On Thursday morning, we heard presentations about work being done by the Chinese themselves. Included in these reports were proton-induced x-ray analysis measurements (PIXE) made on meteorites, biological samples, semiconductor materials, and metals, in collaboration with the three-million-volt Van de Graaff accelerator group at Fudan University. Also presented was some work on the analysis of impurities in highly purified metals by charged particle, activation analysis, which was performed with the cyclotron at the Institute of Nuclear Research.

In the afternoon, the groups were further divided so that each of the four of us could address a discussion group in still greater detail than was possible during the lectures. These discussion groups were continued on Friday morning. In my case, the discussions centered mainly around ion implantation applications to corrosion, wear, friction, and fatigue lifetime effects in metals. The director of the metal corrosion division of the Shanghai Institute of Metallurgy, Dr. Shih Sheng-Tai, took a very active role in these discussion groups, particularly in those parts of the discussion having to do with improving corrosion resistance of metals. Dr. Shih received his Ph.D. from the University of Missouri at Rolla. A particularly important result was achieved by a group from the Institute of Metallurgy, namely, that a large fluence nitrogen implantation of a cobalt-cemented tungsten carbide cutting tool increased the cutting lifetime by a factor of five. The cutting speed and depth of cut were such that the top temperature was estimated to have reached between 800 and 900°C. The results obtained by this group are the first reported reduction of tool wear by ion implantation in a dry hot cutting-tool application.

SHANGHAI RADIO FACTORY NO. 18

On Friday afternoon, we visited Shanghai Radio Factory No. 18, a production factory for television sets. It employs 1700 people, of whom approximately 100 are technical. The factory is producing 9", 12", and 19" black and white television sets and had an output last year of 80,000 sets. The TV sets are attractively designed and housed in handsome wooden cabinets. The 12" set sells in the stores at a price of 400 Yuan. We were informed that 90% of the cost of the set was in the components; the factory manager, therefore, has difficulty in lowering the cost of the sets appreciably by improving the efficiency of his operations.

FUDAN UNIVERSITY

We next visited Fudan University, a comprehensive university with seven liberal arts departments and six science departments. It has 4,000 students, of whom 300 are graduate students, and a teaching staff of 2,100, of whom 800 have just graduated from the university. The science departments are physics, nuclear science, optics, mathematics, chemistry, computer science, and biology. The liberal arts departments are: Chinese history and literature, journalism, economics, international politics, foreign language, and philosophy. The university also has a number of institutes which are concerned with research. Thus, they have institutes of modern physics, electronics, mathematics, genetics, and social science.

At Fudan University, we saw a vertical three-million-volt Van de Graaff accelerator, and heard presentations about some of the work that was being done by the proton-induced x-ray analysis (PIXE) group. Dr. Yang Fu-Chia is the director of the PIXE group and the Van de Graaff accelerator. The Fudan University Van de Graaff runs three shifts per day and four or five days per week, and can accelerate protons, deuterons, alpha particles, and nitrogen ions; it was made in Shanghai. With protons and deuterons, this accelerator can produce a 20-microampere beam on target.

At Fudan University, we heard additional presentations about the work being done there. Among the experiments described were Rutherford backscattering measurements on silicon and silicon dioxide covered with thin gold layers; on garnet material being used for magnetic bubble studies; on GaAlAs being used for solar cells; and on an ancient Chinese bronze mirror. The measurements on the bronze mirror showed that the concentration of tin was higher near the surface than it was in the bulk material, and raised the question as to how this result was achieved when the mirror was first made. One experiment on channeling in silicon was reported in which measurements were made on implanted arsenic before and after various annealing treatments. Channeling measurements were also made on tin implanted into gallium arsenide.

The PIXE group at Fudan University is equipped to do non-vacuum analysis of samples by bringing the beam out into air through a thin foil. Such non-vacuum PIXE analysis was used to analyze the metals and various glasses in the handle of a sword approximately 2500 years old which was made for King Goujian, a famous king of an ancient kingdom in eastern China called Yue. The analysis of the glass in the handle of the sword showed that, at that time, the Chinese already had glass containing potassium and calcium. This result was surprising because previously known old glasses contained only lead and barium. We also heard reports of PIXE measurements on the Kirin meteorite, which fell in China in March of 1976, and which is the biggest known stone meteorite in the world, weighing 1,700 kg. In this meteorite, the analysis was performed on approximately 10 elements. In other experiments which were presented, charged particle-activation analysis was used to look at oxygen, carbon, and boron in silicon, germanium, gallium arsenide, highly pure metals, quartz, and various other minerals. We also heard reports of PIXE analyses of river water, and of an analysis of rat liver tissue in which a comparison was made between normal tissue and cancerous tissue. For the rat liver tissue, preliminary results showed that the zinc concentration decreased and the chromium concentration increased in the cancerous tissue as compared to normal tissue. A report was given also for trace element analyses of human blood, where a comparison was made between the blood from a normal patient and blood from a patient with leukemia. In the patient with leukemia, the blood showed a decreased content of zinc, iron, and rubidium. The Fudan accelerator group presently is using a 400-channel intertechnique analyzer, but has plans to purchase a 4,096-channel analyzer together with a PDP 1134 computer.

The next laboratory we visited at Fudan University was a small production line for bipolar integrated circuits. At the time of our visit, the line was producing a buffer memory for a central processing unit. The buffer had 150 gates and a speed of approximately 5 nanoseconds per gate. As part of this line, we were shown a mask repeater whose position was laser controlled and considered to be accurate to 1 micron.

In Shanghai we were also told about, but did not visit, an optical mechanics institute and two laser research institutes which belong to the Chinese Academy of Sciences, and an institute of welding and an institute for materials research which belong to a Ministry of Machinery. The director of the optical mechanics institute, a

member of the Chinese Academy of Sciences, is Dr. Gan Fu-Shi. The deputy director of the Institute for Materials Research is Dr. Das Tsung-Yao. The laser institutes, one for basic research and one for applied research, employ 1400 and 700 persons, respectively.

After a few days of sightseeing and visits to factories and communes in Soochow and Hangchow, our group travelled from Hangchow to Beijing (Peking) by air, arriving late in the afternoon. At the airport we were met by Dr. Hsu Chen-Chia of the Beijing Institute of Semiconductors, and by Ms. Li Shin-Shih, an administrative official at the institute and its chief officer for foreign affairs. In the evening we met Dr. Wang Shou-Wu, the deputy director of the institute. Dr. Wang received his Ph.D. from Purdue University. The director of the institute, whom we did not meet, is Dr. Huang, who did his early graduate work in England under Professor Mott and who, at a later time, co-authored a book on lattice dynamics with Professor Max Born. We also met the director for administration for the institute, Mr. Liu, and Mr. Li from the Chinese Academy of Sciences offices in Beijing. We learned that Mr. Li had provided very important assistance at the Chinese Academy of Sciences in obtaining approval for our group's trip to China.

On Friday afternoon, Drs. Lau and Mayer visited the Institute of Semiconductors while Dr. Ziegler and I visited the Institute of Physics which was located in another part of the city. At the Institute of Physics Dr. Ziegler and I lectured alternately on ion beam analysis and on ion implantation applications, then separately went to visit several laboratories there. At the Institute of Semiconductors, Drs. Lau and Mayer lectured on ion implantation applications to semiconductors and then also visited several laboratories.

BEIJING INSTITUTE OF PHYSICS

The Beijing Institute of Physics, also part of the Chinese Academy of Sciences, employs approximately 800 people. The director is Dr. Shi Jiu-Wei, and the vice directors are Drs. Guan Wei-Yang and Ho Shuo-Ang. Our escort was Dr. Liu Chia-Jui, who studied at Moscow University and is now the vice director of the plasma physics division. The institute consists of the following divisions: high pressure; low temperature and superconductivity; plasma physics; laser physics; crystallography; magnetism; theoretical physics; and computer applications to physical experiments. Among the experiments we observed were: a study of epitaxial $Gd_3Ga_5O_{12}$ layers on garnet in connection with magnetic bubbles; studies on sputtered thin films of GdCo, Tb, Fe, and FeB; and a Tokomak laboratory. The Tokomak, staffed by a group of about 20 persons, was being operated while we were there; present experiments are oriented mainly toward plasma diagnostics. The goals for the machine are an electron temperature of between 100- and 200-electron volts and an electron density of 10^{12} per cubic cm. The Tokomak group hopes to achieve an ion temperature in excess of 300 electron volts and a confinement time of 20 msec; at the present time the confinement time is only a few msec. Future plans call for the development of a neutral atomic beam which can be injected into the Tokomak. The plasma physics division also has a belt pinch device which is staffed by two groups totalling together approximately 40 persons.

The best known division in the Institute of Physics was reported to us to be the crystallography division; this division has the best crystal-growing capability in China. Presently, in this division are being grown crystals of YAG, GGG, and LiO_3, with the latter material intended for laser studies. The magnetism division is interested in rare earth elements, ferrites, and magnetic bubble materials. The theoretical physics division is interested in quantum field theory and in gravitational waves. We were told that a gravity wave apparatus is in operation in this division.

Located not far from the Institute of Physics are an institute of automation which employs approximately 900 people, an institute for chemical metallurgy, an institute for electronics, which employs approximately 1,000 people, and an institute for computational mathematics. This latter institute has a Data General Corporation NOVA large computer which is used by the members of the Institute of Physics for their calculations.

BEIJING INSTITUTE OF SEMICONDUCTORS

On Friday also, we visited several laboratories of the Beijing Institute of Semiconductors. This institute, part of the Chinese Academy of Sciences, was founded in 1960 and employs approximately 900 persons, of whom

about 500 have technical degrees. Our escort was Dr. Hsu Chen-Chia, the director of the division for physical and chemical analysis of semiconductors. Dr. Hsu worked at Reading University in England. His division presently employs approximately 60 persons but is expected to grow to about 100 persons in the next two years. Some of the groups we visited in this division were: a group whose equipment includes Hall mobility, CV measurements, and a deep-level transient spectroscopy (DLTS) apparatus; a group on optical properties that is interested in infrared absorption, photoluminescence, photoconductivity, and photothermal ionization spectroscopy; an x-ray group that performs topography and rocking curve measurements, and has a scanning electron microscope and an electron microprobe. This latter group is planning, by the end of this year, to acquire a sputtering Auger electron spectroscopy apparatus. There are also groups on atomic absorption and chromatography. Finally there is an ion-beam analysis group which performs most of its measurements on a 2.5-million-volt Van de Graaff accelerator which is owned and operated by the Institute of High Energy Physics, located close to Tsing Hwa University.

On Saturday afternoon, we again visited a number of laboratories of the Institute of Semiconductors. The first laboratory we saw was an "Ultrapure Line," which was being used to produce a 256-bit random-access memory (RAM) and for basic research on yield problems. In this laboratory, a helium-neon laser was being used for measuring the film thickness for a chemical vapor-deposition (CVD) epitaxial layer apparatus. Here we also saw class 1,000 rooms with hoods which were reported to be class 100 (class = number of particles per ft^3 with diameter > 0.3 μm). In this laboratory, we also saw a scanning electron microscope which had been made in China in approximately 1975; it had a 100 Å resolution and a magnification of approximately 100,000. The laboratory also owned a Japanese electron microprobe and scanning electron microscope which included double-focusing x-ray crystal detectors on both sides of the sample.

In the next laboratory we visited, we were told about experiments being performed on $GaAs_{1-x}P_x$ which had been implanted with nitrogen and zinc. In these samples, measurements were being made on the number of isoelectronic traps present as a function of annealing temperature. In another experiment which was described to us, electron-beam-induced luminescence images of dislocations were compared with scanning electron microscope photographs and with x-ray topography measurements. In still another laboratory, we saw work being performed on a GaAs planar Gunn diode. So far, for these diodes, a transfer delay time of 100 picosec has been obtained, but the energy loss is still too large for application in digital circuits. This group has done some computer simulation of the Gunn domain at the Beijing Computation Center, a center that belongs to the city of Beijing.

INSTITUTE OF HIGH ENERGY PHYSICS

On Saturday morning, we visited the Van de Graaff at the Institute of High Energy Physics. The accelerator was in operation at the time of our visit and we could see the luminescence produced where the beam was incident on a quartz plate in the target chamber. Next to the target chamber, there was a Canberra Model 30, 2,048-channel pulse height analyzer. In an adjacent room, there was a new Canberra Scorpio computer and multichannel pulse-height analyzer system. The unit consisted of a 4,096-channel analog to digital converter, a PDP 1134 computer with 32 K of memory, a line printer, keyboard, CRT display, teletypewriter, and a Hewlett-Packard plotter. Among the samples being analyzed with this equipment were SiO_2 Si_3N_4, PbO on SiO_2, and silicon on sapphire. Rutherford backscattering results on this latter sample indicated that the aluminum is diffusing into the silicon epitaxial layer. The samples of silicon on sapphire were prepared by the materials division of the Institute of Semiconductors, the silicon layer being approximately 3,000 Å thick.

NAN KAI UNIVERSITY

On Sunday evening, I had a visit with a classmate of mine in graduate school, Dr. Ho Kuo-Chu. Dr. Ho is now the chairman of the physics department at Nan Kai University in Tian Jin (Tien Tsin). His department has a staff of 200, which is divided into the following six branches: electronics, semiconductors, solid state physics, optics, theoretical physics, and vacuum physics. Dr. Ho told me that he was hoping to acquire an ion implantation accelerator for his department in the next year or so, and that, in the longer term future, he was hoping also to acquire a Van de Graaff accelerator. Dr. Ho received his Ph.D. degree in theoretical nuclear physics from the University of Notre Dame.

TSING HWA UNIVERSITY

On Monday morning, May 28th, we visited Tsing Hwa University in Beijing. This technical university was established in 1911 and now has approximately 5,000 students, about one-half of the number in attendance in 1966. The 13 departments of this university are: electrical power engineering; electronics and computers; engineering physics; nuclear engineering; industrial engineering and automation; radio electronics; mechanical engineering; heat; precision instruments; civil engineering; hydraulic engineering; engineering mechanics; and engineering chemistry. Our escorts were Dr. Liu Pai-Hsin, director of the department of engineering physics and head of an ion accelerator group, and Professor Li Heng-Te, director of the department of nuclear engineering. Tsing Hwa University emphasizes engineering and technology and requires five years of training on the part of its students, whereas the normal university in China requires only four years. After our reception, we went to visit a pilot line which was producing a 1024-bit random-access memory (RAM) with a 500-nanosecond cycle time. This RAM had been designed without the aid of computers, uses polysilicon gates and aluminum metallizations, and has a refreshing cycle time of 2 milliseconds. The production line in the future will use an 80-kV ion implanter for adjusting the threshold voltage for static RAMs which will be made and which will operate at 5 volts. The dynamic RAMs presently being made require 100 milliwatts of power and operate with bias voltages of −18 and +4 volts. The yield reported for the 1024-bit RAMs was 20%.

We next visited a laboratory in which a 400-kV Cockroft-Walton accelerator was being rebuilt and converted to a 200-kV ion implantation accelerator for use with heavy ions. The goal for this accelerator is to achieve between 2 and 3 milliamperes of ions at the ion source extractor electrode. The design for the machine has been finished and the group hopes to complete the machine by the end of 1979. The accelerator will run at 50 cycles and will have two stages of voltage doubling.

Tsing Hwa University also has a smaller ion implantation accelerator and a group working with it has performed some nitrogen implants into metal cutting tools to see if wear reduction could be obtained. The tool results are not yet complete. In a related set of experiments, a pin approximately 1.5 mm across was implanted with nitrogen and some wear tests on this pin were performed by running the pin against an unimplanted steel cylinder four inches in diameter. In these tests, the pin wear was reduced by approximately a factor of two.

BEIJING SILICON DEVICES FACTORY NO. 3

On Monday afternoon, Dr. Ziegler and I visited the Beijing Silicon Devices Factor No. 3, which is engaged in manufacturing integrated circuits. During the same afternoon Drs. Lau and Mayer went to visit Beijing Normal University. The integrated circuit factory is making both CMOS and bipolar high-threshold logic integrated circuits. It has approximately 1300 workers, 600 of whom are actually engaged in the integrated circuit fabrication; the rest are administrative and support personnel and those who are developing new circuits and new designs. Approximately 175 persons are university graduates. The annual output of the factory was reported to be two million integrated circuits of several types. Initial designs are being developed now for fabrication of large-scale integrated circuits; large scale was defined as a circuit which had 1,000 gates or more. The high-threshold logic, bipolar integrated circuits are used for industrial control so they are designed to be much more resistant to noise than ordinary circuits. They work on a bias voltage of 15 volts. The factory was founded in 1969 but has been producing integrated circuits only since 1975. At the present time, they are using a wafer diameter of 38 mm, but they hope to go to a 76-mm diameter in one or two years. Engineers at the factory try to spend one day per week on continuing education. The factory starts 500 wafers per day and uses 20 wafers per diffusion. The production line included two 60 kV ion implantation accelerators which were used for boron implantations into the Si 100 face for the CMOS P-well. The yield was reported to be between 30 and 40% for small-scale integration and 20% for medium-scale integration. We saw 256-bit static RAMs being produced and were told that, in the future, the factory will produce a 2,048-bit static MOS RAM and also a 2,048-bit EPROM.

Our group flew from Beijing to Kwangchow on May 29 and then went by train to Hong Kong on May 30. We were all of the opinion that our trip was mutually rewarding. We felt that our technical lectures would prove to be helpful to our Chinese hosts in their future research; and we, for our part, certainly learned a great deal

about Chinese science and technology and about China itself. We left China with feelings of deep gratitude for the wonderful opportunity the Chinese had given us to visit them and for their kind and most generous hospitality, and we hope that the many friendships we formed will now be the basis for a continuing and fruitful scientific exchange.

TIDAL FLAT MUDS IN THE REPUBLIC OF KOREA: CHINHAE TO INCHON

John T. Wells and Oscar K. Huh

INTRODUCTION

The coastal areas of the Republic of Korea provide an unusual setting for geologic and oceanographic studies. Whereas the east coast is characterized by rocky bluffs with intervening sandy pocket beaches, the south and west coasts are fronted by extensive mudflats, turbid waters, and hundreds of small, conical islands. The south coast of Korea, bordered by the Korea Strait, and the west coast, bordered by the Yellow Sea, are referred to by classical geologists as "submerged coastlines." A relative rise in sea level, together with rugged topography, has resulted in a maze of islands and crenulated coastlines with many peninsulas. The coastal indentations provide conditions favorable for ports in the south; however, siltation, high-tide range, and accumulations of mud into dangerous shoals make navigation and development of ports along the west coast quite difficult.

With the exception of the east coast, bordering the Sea of Japan, the shorelines of the Republic of Korea are excellent examples of a "muddy coast." The common attributes of a muddy coast are high concentration of suspended sediment in coastal waters, and beaches formed almost exclusively from silt- and clay-sized particles. The predominance of find-grained sediment in coastal waters and on beaches is important in the rate of wave attenuation and sediment transport, beach morphology, and biological habitat. Although one-quarter of the total coastline in North and South America, and perhaps a similar percentage worldwide, may be described as muddy coast, the most basic descriptive information about these coastal environments is often lacking. Further studies in environments such as that to be described below are long overdue.

This report documents visits during the last two weeks of June, 1979, which began at Chinhae, on the south coast, progressed west as far as Mokpo, then moved north to Inchon (Figure 1). The five major stops shown in Figure 1 ranged in duration from a few hours to overnight. Shorter stops, far too numerous to be detailed here, were made between major stops for the purposes of taking photographs and collecting samples. At two locations on the west coast (stops 4 and 5), we had the opportunity to spend a part of a day walking on (and through) some of the best-developed tidal mudflats in Asia.

Extensive "gelatinous" mudflats extend many kilometers seaward of the high-tide line and, as reported by Bartz (1972), some 2827 km^2 (1100 mi^2) of tidal flat muds are exposed on the west coast at each low tide. Tide range varies significantly from the southeast tip of Korea near Pusan, where spring tide range is less than 2 m, to the large embayments near Inchon, where spring tide range exceeds 9 m. Influences of tide range and storms on mudflat morphology, development, and fine-sediment movement have not been studied and are a frontier area of research.

SOUTH COAST

STOP 1: CHINHAE

We first encountered the rugged mountainous terrain of the south coast as we traveled from Chinhae initially to Masan, then left the main highway for one-lane roads in the peninsular areas to the south (Figure 2). Rugged hillsides, 400-500 m high, gave way abruptly to embayed mudflats 10-25 km wide. Spring tide range along this stretch of the coast is approximately 2 m, a range sufficiently large to allow one to see subaerial mud exposures

over broad areas at low tide. In fact, we observed that some embayments were completely drained at low water (Figure 3). Muds that formed basin sediments ranged in color from medium to dark brown and were firm enough for local fishermen to walk across, their feet sinking only centimeters into the mud. (*In situ* density, based on subsequent laboratory determinations, exceeded 1.6 g/cm^3.) Parabolic sand bars, 0.5 m high and up to 25 m long, stood in contrast to the muds because of their yellow-brown color and gave topographic relief to mudflats in some areas. These accumulations of sand apparently were the result of concentration by swift tidal currents, reported to be on the order of 1-2 knots.

Fine-grained sediments that front the coast as mudflats appeared to be derived locally from deeply weathered and dissected granitic rocks found in the mountain ranges of the south and east coasts. According to published reports (Park et al., 1976), predominant clay minerals in Chinhae Bay are illite (45%), kaolinite (23%), and intergrade clay (17%), with small amounts of smectite and chlorite. Scientists believe the distributional trends of these clay minerals indicate that some transport landward, from the East China Sea, has taken place, in addition to that from local deeply weathered rocks. Coarser particles show a wide distribution of sizes, indicating a relatively short transport distance and continued supply of rock scree from local runoff.

The Naktong River, one of the largest in Korea, supplies great quantities of fine-grained sediments to the south coast near Pusan. The influence of these sediments on the mudflats in the vicinity of Chinhae is unknown. However, the Tsushima current in the Korea Strait reverses its direction twice a day and flows west on an ebbing tide, possibly carrying a substantial amount of sediment with it.

We arrived at Chungmu for a view of the more open mudflats seaward of the tightly enclosed embayments near Chinhae. The morphology was similar to that at Chinhae, and proximity to Chinhae Bay Suggests similar mineralogy and source areas. From Sachon, to the north, we began a five-hour drive on dirt roads along the shoreline of Kwangyang Bay (Figure 1). These muds were covered by thin layers of sand and gravel from locally weathered rocks nearby. Angular particles in the pebble size range ($>$ 4 mm) were common at this stop, and occasionally small creeks could be seen carrying sediments from hillsides out onto mudflats and depositing them as miniature deltas.

As the tide rose over the mudflats at Kwangyang Bay, west of Chinhae, the waters were exceedingly clear, suggesting that, in the sheltered basins of the south coast, little resuspension of muds by waves or even tidal currents occurred. As scientists have observed in many other parts of the world, dense muds are often more resistant to erosion than much coarser sand-sized particles (Postma, 1967; Thompson, 1955).

STOP 2: YOSU

Yosu is located on a peninsula that has narrowly escaped becoming an island; only a thin neck of land separates it from the mainland (Figure 1). Tide range is 3 m, thus allowing slightly larger exposures of mud at low tide. Tidal flat muds near Yosu were morphologically similar to those seen earlier, with prominent surface features being freshwater stream channels and (presumably) tidal sand bars. Waves were virtually absent in embayed areas and, again, little resuspension of mud occurred during the period of observation. During the day as we traveled west we began to encounter stream channels across mudflats that were braided (Figure 4). Since braided streams are typically found in coarse-grained sediment under conditions of erratic discharge, their occurrence on tidal flats is considered unusual.

Because of the richness of the coastal sediments, crowded conditions, and the ingenuity of the Korean people, much of the embayed shoreline is being heavily reclaimed for rice cultivation (Figure 5). This reclamation is so extensive that coastal charts must be updated each year in order to delineate land-sea boundaries.

STOP 3: MOKPO

Upon our arrival at Mokpo, we took a ferry to Aphae-Do, a small pinwheel-shaped island to the northwest (Figure 1). For several hours we traveled on gravel roads around the island, making frequent stops to observe and

photograph the mudflats. Several narrow necks of land on Aphae-Do gave us the opportunity to observe simultaneously tidal flats to the east (landward) and west (seaward). Little morphological difference could be seen between areas east and west, or between these mudflats and those at Chinhae.

However, as the tide rose over the mudflats, waters became noticeably more turbid, and Mokpo clearly suggested to us the beginning of the Yellow Sea influence. Tide range is 4 m at spring tide, and constrictions formed by islands and peninsulas result in tidal currents up to 8 knots during flood and 11 knots during ebb (U.S. Naval Oceanographic Office, 1951). Particle size appeared to be quite small near Aphae-Do, in contrast to surface material on some earlier mudflats, and sediments were easily suspended by these strong currents.

We returned to Mokpo for the night and traveled north the following day to the shoreline of Chang-Po (Figure 1). Surficial sediment maps, constructed by Kim and Chang (1979) for the area southeast and northwest of Chang-Po Bay, show an extremely wide distribution of sediment sizes. Muds are the dominant sediment immediately around Aphae-Do, but coarse sands and gravel are present within a 10-km radius. Tidal currents undoubtedly play a major role in distribution of these shallow-water sediments. Generally the mudflats in this complicated region have very poorly sorted particles, an indication of variation in tidal current strength, sediment source, distance of transport, and complicated bathymetry.

Our south coast visits ended with the return to Chinhae via the new Namhai toll road, which took us across the Yongsan Plain east of Mokpo, the Sobaek Mountains, and the Naktong River Basin.

WEST COAST

One-day field trips to Kunsan and Inchon, on the west coast, arranged through Dr. Sung Kwun Chough of Seoul National University, were perhaps the highlights of our visit to Korea. Although one can easily drive to coastal regions by jeep from Chinhae to Mokpo, the west coast is considerably more difficult to reach, primarily because of tight national security.

STOP 4: KUNSAN

Spectacular mudflats are developed at the entrance to the Kum River, where tide range is 5 m. Fewer islands are present on the west than on the south coast, and the Kum River flows out into a broad but crenulate embayment (Figure 1). Navigation charts show that the shelf gradient is gentle and, when combined with tide information calculations, indicate that mudflats should be exposed as far off-shore as 15 km.

From the town of Kunsan, we took a taxi to the mouth of the Kum River and, as tide receded, walked out onto the mudflats. These tidal flat deposits differed considerably from those of the South coast: sediments were finer, biological activity was more prevalent, and a dendritic drainage system for tidal waters was extremely well developed (Figure 6).

Our arrival coincided exactly with the time of high tide, and we were able to watch for the next several hours the processes by which an embayed mudflat became exposed subaerially. Waters initially receded as a sheet, first over a nearshore region of fine sand, then over gelatinous fluid muds farther seaward. Within an hour, receding waters on the inner 1 km of mudflat were confined exclusively to an intricate system of tidal drainage channels. These sinuous channels ranged from a few centimeters to more than 2 m wide. As in a subaerial network of tributaries to a river, the smaller channels led into larger ones, and finally intersected the sea surface on the inner shelf.

Figure 7 shows the typical pattern of a steep-sided drainage channel 1 m wide and 0.5 m deep. Tidal waters, that flowed seaward in channels across the mudflats, were heavily laden with sediment. Determinations made from water samples collected in channels indicated that suspended-sediment concentrations were $5\text{-}10 \times 10^3$ mg/l, values 5-10 times higher than those of the Mississippi River water during flood stage. Much of the sediment

carried seaward was scoured from areas that had been bioturbated by crabs and bivalves. The enlargement by tidal waters of these natural burrows gave the mud surface a pockmarked appearance (Figure 7).

As we traversed through knee-deep muds following the outgoing tide, we noticed particularly the consistency and size uniformity of these sediments. Even to a casual observer, the muds at Kunsan would appear softer and less dense than those of the south coast. Subsequent laboratory analysis of samples showed that these sediments are indeed much finer in size, with some 90-95% of each sample being less than 63 microns in diameter, and that densities range from 1.3 to 1.6 g/cm^3. A soft upper layer of oxidized brown mud, 20-30 cm thick, overlies steel-gray muds. We believe that the thickness of the overlying mud layer may be an indicator of the depth to which muds are cyclically resuspended and deposited.

STOP 5: INCHON

The mudflats at Inchon, near the mouth of the Han River, are dominated by one of the highest tide ranges in the world. Spring tide range exceeds 9 m in this part of Korea, and tidal flat deposits maintain subaerial exposure to at least 50 km offshore at low tide.

Mudflat morphology, although similar to that at Kunsan, was somewhat less spectacular (Figure 8). Despite the high tide range, drainage channels were less than a meter across and proportionally shallower. However, small disk-shaped depressions, presumably from the scour of rising tide waters, were more common than at Kunsan. Muds were generally denser (> 1.6 g/cm^3) and, as shown in Figure 9, appeared to be less active biologically. The enormous amount of tidal energy supplied to the mudflat surface undoubtedly affects the ability of organisms to colonize in this environment.

As we walked seaward we were surprised to find that the soft oxidized layer of mud was never more than 3-5 cm thick and that muds appeared to have remained stable for several months preceding our visit. However, during storm conditions associated with cold-air outbreaks in winter, the muds almost certainly undergo significant morphological changes. Although waves are naturally attenuated over muddy bottoms, our experience in other areas has shown that seas can build high enough in a few meters of water to cut steep scarps and remove many meters of mud during a single-storm event.

We came to the conclusion early that dynamics of the south and west coast mudflats are very poorly understood and that much remains to be learned. Research programs in the study of tidal flat dynamics should be focused on:

1) Effects of tide and severe winter storms on sediment redistribution and shorline change,
2) Role of drainage channels in delivering sediment seaward and in the overall sediment budget,
3) Movement both landward and seaward of sediment plumes from major rivers,
4) Effects of frozen interstitial pore waters on mudflat stability, and
5) Modification of nearshore wave climate by tidal flat deposits.

Knowledge in these areas would be extremely beneficial to Koreans by providing them with information useful to navigation and harbor siltation, building of ports in unstable coastal muds, reclaiming land for agricultural purposes, and shoreline defense. Although study of tidal flats in Korea is just beginning, interest is understandably strong and support from government agencies of the Republic of Korea appears to be good.

REFERENCES

Bartz, P. M., 1972. South Korea. Clarendon Press, Oxford, 203 pp.

Kim, S. W., and Chang, J. H., 1979. Sedimentological properties of the bottom sediment between Mokpo and Cheongsan Island, off the south coast of Korea. Dept. on Geoscience and Mineral Resources, KIGAM, 5:5-44.

Park, B. K., Han, S. J., and Lee, J. W., 1976. Clay mineralogy of bottom sediment in the Jinhae Bay, Korea. Jour. Oceanogr. Soc. Japan, 32:219-227.

Postma, H., 1967. Sediment transport and sedimentation in the estuarine environment. In G. H. Lauff (ed.), Estuaries, Am. Assoc. Adv. Sci. Publ. No. 83:158-179.

Thompson, W. C., 1955. Sandless coastal terrain of the Atchafalaya Bay area, Louisiana. In J. L. Hough and H. W. Menard (eds.), Finding Ancient Shorelines, SEPM Spec. Publ. No. 3:52-76.

U.S. Naval Oceanographic Office, 1951. Sailing directions for the southeast coast of Siberia and Korea. H.O. Publ. No. 97, Government Printing Office, Washington, 484 pp.

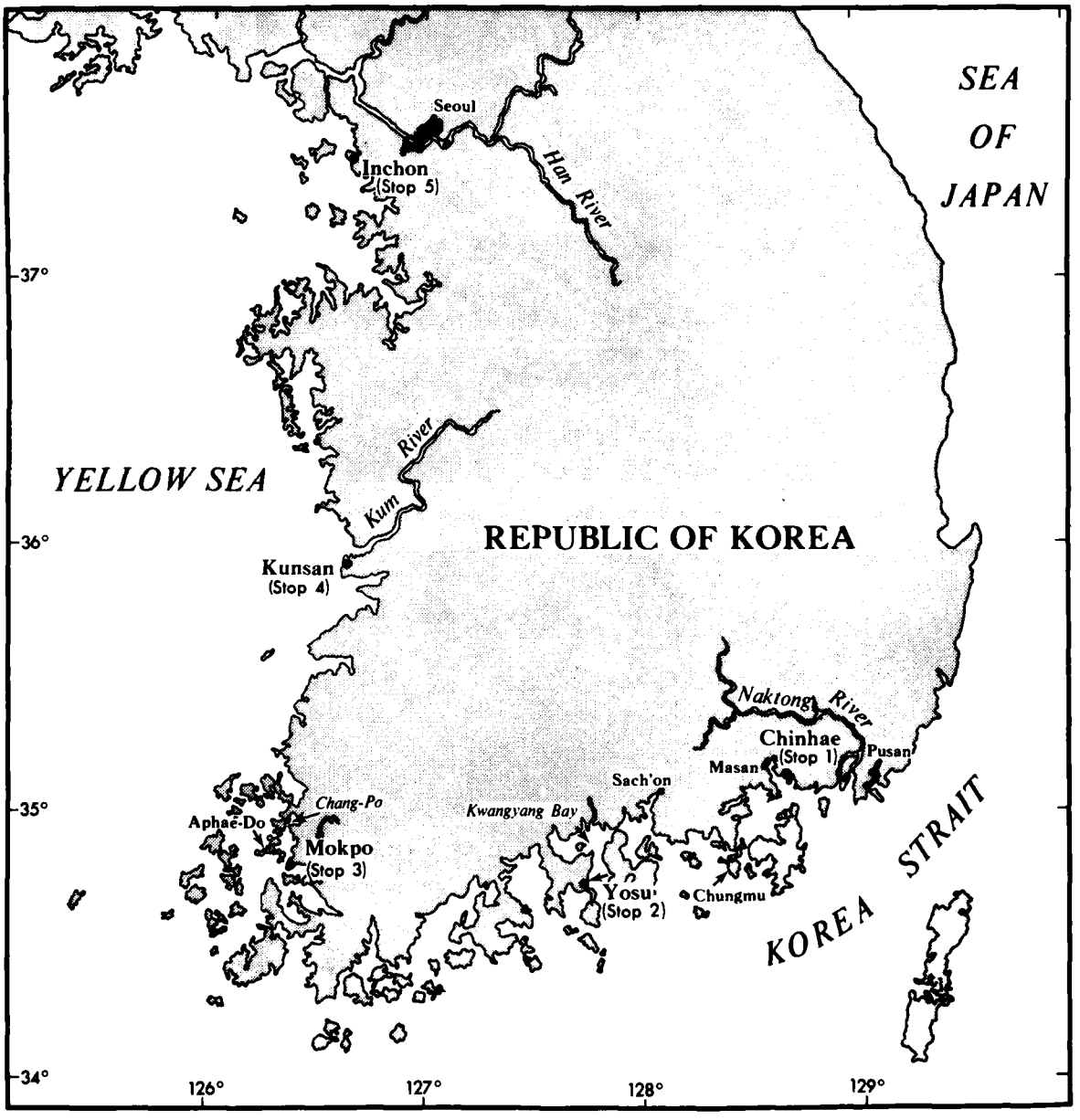


Fig. 1. Index map of Republic of Korea showing major stops during coastal visits.

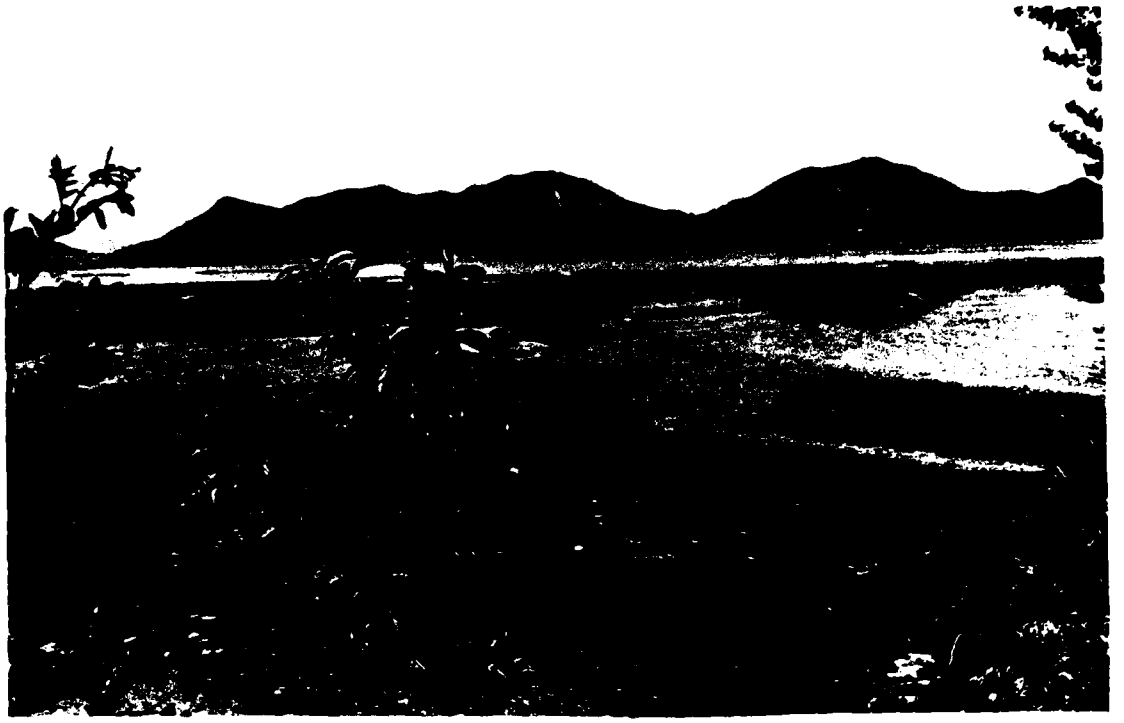


Fig. 2. Coastal embayment surrounded by conical hills, vicinity of Chinhae. Photographed at low tide.

Fig. 3. Embayment drained at low tide.

Fig. 4. Braided freshwater streams, west of Yosu.

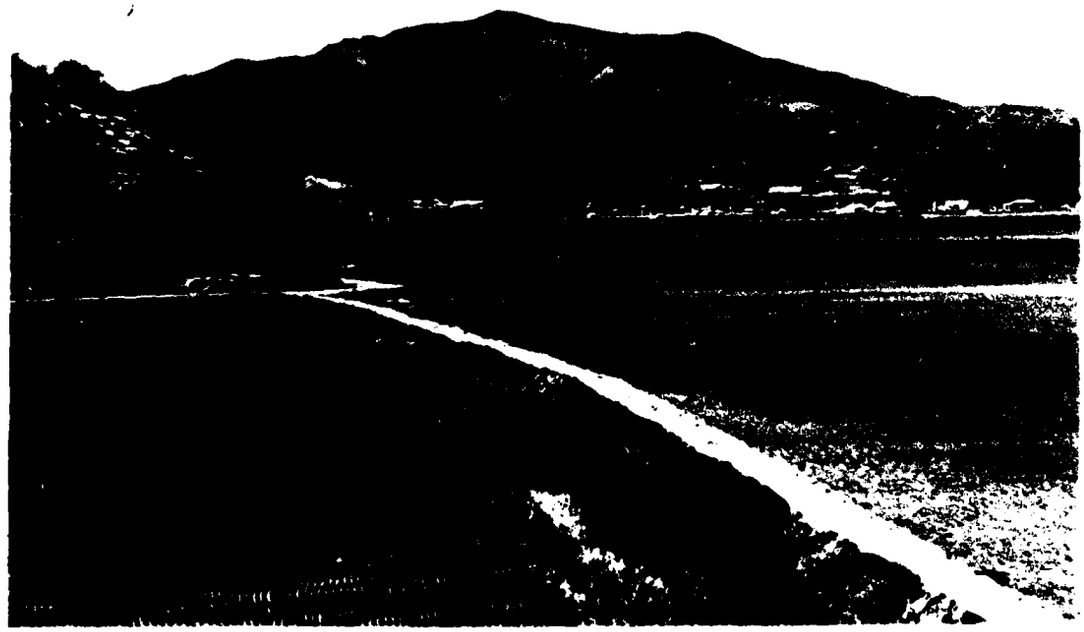


Fig. 5. Mudflat (right) and land reclaimed for rice fields (left), vicinity of Yosu.

Fig. 6. Intertidal mudflat near entrance to Kum River. Note abundance of crabs and bivalves on mud surface.

Fig. 7. Details of drainage channels and pockmarked mud surface on ebbing tide. Width of channel is 1 m.

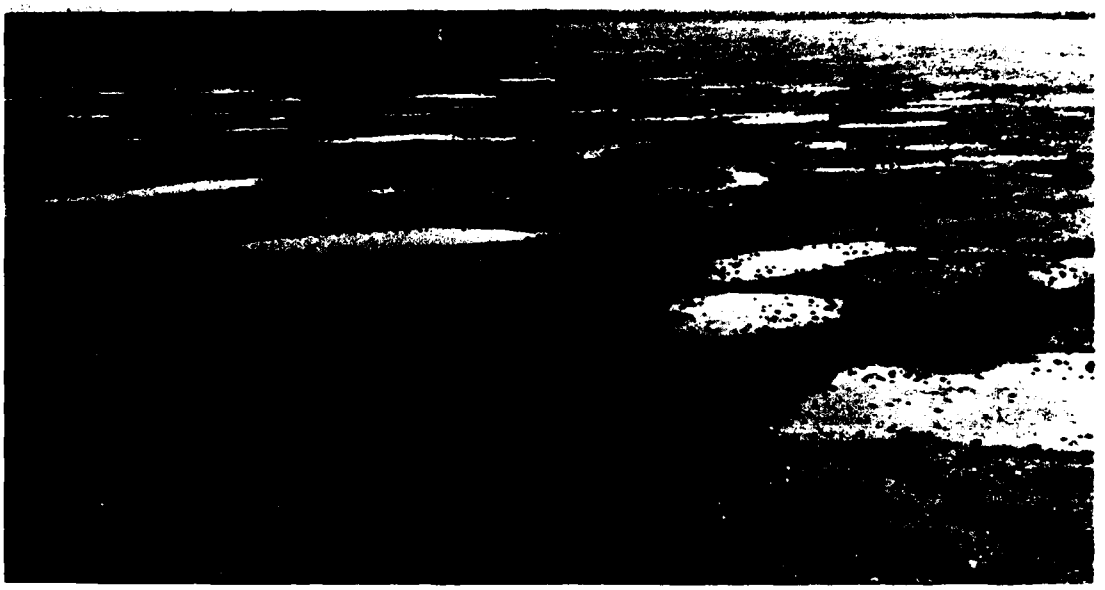


Fig. 8. Intertidal mudflat near entrance to Han River. Note dish-shaped scour depressions.

Fig. 9. Dr. Chough lecturing to oceanography students from Seoul National University on relatively barren mudflat at Inchon.

APPENDIX

RESEARCH AGENCIES

Our tour of the south and west coasts of Korea brought us into contact with a number of organizations that have both basic and applied research programs in the field of marine geology. Table 1 provides a list of organizations that were visited and scientists with whom we spoke.

Table 1

Scientists contacted during coastal visits

Organization	Scientists
Chinhae Research Laboratory Chinhae, Kyongnam Republic of Korea	Dr. JungUck Seo (director) Dr. Jong Wha Lee (marine biologist) Dr. Jung Yul Na (physical oceanographer)
Korea Institute of Science and Technology (KIST) P.O. Box 131 Dong Da Mun Seoul, Republic of Korea	Dr. Sangbok D. Hahn (physical oceanographer) Dr. Kwang Woo Lee (chemical oceanographer) Dr. Heung Jae Lie (physical oceanographer)
Korea Research Institute of Geoscience and Mineral Resources (KIGAM) 219-5, Kari Bong-Dong Yong Dung po-Gu Seoul, Republic of Korea	Dr. Byung Koo Hyun (president) Dr. Chong Su Kim (vice president)
Seoul National University Seoul 151	Dr. Sung Kwun Chough (marine geologist) Dr. Jong Yul Chung (physical oceanographer) Dr. Kuh Kim (physical oceanographer) Dr. Jae M. Shim (marine biologist) Dr. Frank Kilmer (paleoecologist–visiting scientist from Humboldt State University) Dr. Hsin Yi Ling (geologist–visiting scientist from Northern Illinois University)

XIV PACIFIC SCIENCE CONGRESS

Ned A. Ostenso

The XIV Pacific Science Congress was held in Khabarovsk, U.S.S.R. from 20 August to 5 September 1979. There were pre- and post-session field trips. The congress is sponsored by the Pacific Science Association, which was founded in 1920 at the first Pan-Pacific Science Conference in Honolulu. Congresses are now held every four years in a different member country. Since the original meeting in Hawaii, PSA congresses have been held in: Australia, 1923; Japan, 1926; Indonesia, 1929; Canada, 1933; United States, 1939; New Zealand, 1949; Philippines, 1953; Thailand, 1957; Hawaii, 1961; Japan, 1966; Australia, 1971; and Canada, 1975. The XV Pacific Science Congress is scheduled for New Zealand in 1983.

Although each congress has a special theme, the program covers a broad spectrum of physical, biological, medical, and social sciences relevant to the Pacific Ocean itself and to circum-Pacific countries. The theme for this meeting was "Natural Resources of the Pacific Ocean–for the Benefit of Humanity." Academician Alexander V. Sidorenko, vice-president of the U.S.S.R. Academy of Sciences, served as chairman of the organizing committee and president of the congress.

The congress was divided into 14 sessions of unequal emphases. As reflective of the programmatic skewing, which may have been due to the thematic topic, the numbers in parenthesis after each section title is the number of programmed papers in that section. The sections were: conservation and environmental protection (84), solid earth sciences (308), geography and Pacific island ecosystems (133) (met jointly this year), marine sciences (453), coral reefs (27), botany (36), forestry (29), freshwater sciences (43), entomology (55), social sciences and humanities (140), public health and medical sciences (125), nutrition (46), and science communication and education (24). From the foregoing, it can be seen that slightly over half of the attention was on soild earth and marine sciences.

The indicated number of papers cannot be taken too literally because of the large number of scheduled participants who did not show up for the meeting. The cancellations were massive from the U.S. delegations due to logistical and programmatic uncertainties. Final programs with dates were not available prior to arrival at the congress, and Khabarovsk, under the best of conditions, is an extremely difficult place to reach. Dealing with the vagaries of Intourist greatly compounded the problem to the point of discouraging planned attendees.

Like the program, the congress attendance was very much lopsided. Registration lists were not distributed, but my guess would be that there were about 1,000-2,000 participants, with from two-thirds to three-fourths coming from the Soviet Union. The second largest delegation, by far, was from Japan. The United States was represented by probably no more than 100 participants. Canada had a relatively large delegation. Generally, the Pacific island states and territories (such as Fiji, Guam, Papua-New Guinea, Philippines, New Zealand, etc.) were well represented relative to their sizes. South and Central America were very poorly represented.

The program was coordinated out of Khabarovsk and Moscow (separated by seven time zones), the sessions were scattered throughout the city in five locations, and there were substantial cancellations. These factors led to confusion in scheduling which hampered the whole congress.

Although I was told that the anthropology session was truly outstanding and that the tsunami symposium was very good, there were many complaints as to substance. The three sections in which I personally participated (solid earth sciences, marine sciences, and science communication and education) could be characterized as

Russians talking to Russians. Although this was of some interest in itself, the non-Russian speaker suffered from inadequate translation facilities. One item of particular interest was the disagreement amongst the Russians on many scientific issues and the heated debates that ensued. All in all, the congress permitted certain insights; however, there was no peering over the horizon of new discovery. However, it was an unusually good opportunity to renew Soviet acquaintances and to make new contacts.

Khabarovsk is one of the oldest cities in the Far East and has a population of half a million. Located on the Amir River, it is a major center of trade and industry. The population is obviously sensitive to the fact that they are only a few tens of kilometers from the Chinese border. The city is as modern and attractive as any of the ten or so that I have visited in the Soviet Union, and the shops appear to be much better stocked than elsewhere in European Russia or the Crimea.

Immediately preceding the Khabarovsk congress, there was a six-day Soviet-American symposium on physiology and biochemistry of marine animal adaptation in Nakhodka. This symposium was held under the auspices of the U.S.-U.S.S.R. bilateral agreement on cooperative studies of the world ocean. Several U.S. scientists participated under ONR's ocean science and technology division sponsorship. Conveners were A. V. Zhirmunsky (U.S.S.R.) and John E. Vernberg (U.S., Director, Belle W. Baruch Institute for Marine Biology Coastal Research, University of South Carolina, Columbia, SC 29208). The participants reported that the meeting was most successful with the technical papers being of very high quality.

PACIFIC SCIENCE CONGRESS: FUTURE DIRECTIONS

Thomas A. Gosink

(Editor's note: The *Scientific Bulletin* has received a number of reports, both oral and written, which second Dr. Ostenso's description of the XIV Pacific Science Congress at Khabarovsk. One of these was by Dr. Gosink, who also deposited a complete set of abstracts at the *Bulletin* office. Copies of individual abstracts will be supplied upon request.

Dr. Gosink attended the pharmacology and hydrochemistry sessions, as well as the plenary sessions and meetings of the geography and Pacific island ecosystem committees. His account of the closing plenary session is quoted in full for the insight it may give into the priorities of the Congress members and/or organizers.)

CLOSING PLENARY SESSION

It was resolved that, in addition to English, the language of the host country should be the official language at future congresses.

As best as I could pick out of the flowery language and scribble down, this is the essence of the resolutions accepted by the Executive Committee.

Botany

- Concentrate on systemic and taxonomic studies, particularly in the Pacific islands and coastal mainlands
- Plant virus studies should have priority.
- Exchange of information and research for agricultural development is important.
- Coral reefs, sensitive indicators of pollution, need to be identified and reserved.
- Stop coral-reef harvesting for decorative purposes.

Geography

- Work with the man-in-the-biosphere program.
- Urge nations with interest in Pacific islands to establish reserves.

Forestry

- Control cutting and renewal.
- Inventory needs to be taken, and cross disciplinary work needs to be encouraged.

Fresh Water

- The intensive impact of industry, subarctic mineral discharges, and pollution, is getting serious.
- Study the economics of fresh-water utilization and reserves.

Entomology

- Control infectious vectors of crops and forests.
- Develop biological pest controls.

Marine Science

- Air-sea interactions are critical and have direct impact on mankind.

Marine Science (*continued*)

- Ocean monitoring of air-sea interface was called for.
- Exchange information through existing channels of ocean centers and world data banks.

Nutrition

- Focus on new foods sources.
- Eliminate dietary deficiencies in many parts of the Pacific.
- Develop protein from the sea and rationalize distribution.

Public Health and Medicine

- Safeguard sea products from pollution.
- Institute influenza program.
- Pay more attention to "traditional" oriental medicine.

Social and Humanities

- Work should be based on scientific developments. Need further fundamental research on human systems and environmental interactions so that rational administrative control decisions can be made.
- Increase recognition of small nations and their desires.
- U.N. was asked to hold a program on the teaching of cultural heritages in the South Pacific.

Solid Earth

- Fundamental problems cna be solved in the Pacific; there are valuable minerals available. Joint investigations were called for.

Special Resolutions

- Establish Pacific island biosphere reserves in Caledonia in perpetuity. Genetically preserve flora as well as unique ecosystem. Request France to cooperate with appropriate multinational agencies.
- Ecuador was praised for its conservation of the Galapagos Islands. U.N. and Ecuador were asked to continue support of research and strict conservation.
- An appeal was made to the industrialists of East and West to respect the environment and culture of the developing countries.
- Development is desired, but on a sound ecological basis.

THE THIRD INTERNATIONAL CONGRESS OF SLEEP RESEARCH

Paul Naitoh

Some scientists as well as some engineers might be rather surprised to learn that several hundred distinguished physicians, physiologists, psychologists, and biomedical engineers gathered together in Tokyo to discuss sleeping and dreaming. This is a report on such a gathering as seen by a psychologist, with personal commentary.

The Third International Congress of Sleep Research was hosted by the Japanese Society of Sleep Research (JSSR) in cooperation with the Association for the Psychophysiological Study of Sleep (APSS). The congress was held in the Nihon Toshi Center, Tokyo, July 27-31, 1979, and was attended by nearly 500 persons from 30 countries (Table 1). The congress also served as the 19th annual meeting of the APSS. Four symposia and four workshops were held. More than 100 papers were presented orally, and an additional 150 papers were displayed and debated at the poster sessions.

The symbol of the congress was the goddess of mercy, Yumetagae Kannon, treasured by the Horyuji temple in Nara, Japan. She was believed to have the power to dispel evil dreams. To set the tone of the congress, the unique Japanese way of perceiving sleep and dreams was described by Jikai Fujiyoshi in his special lecture on "Dreams and Sleep in the Buddhist Scriptures." Fujiyoshi related that sacred dreams of the "pure and in the west" happily dreamt by a well-respected and trusted priest, Zendo (613-681 A.D.), gave others faith "to be born in the pure land." Zendo's sacred dream came after intense devotion, such as making his daily "prayer in front of the Buddha image reciting the Amita-Kyo three times a day, and calling the name of Amita-Buddha 30,000 times a day." A more recent Buddhist, Suzuki Shosan (1579-1655 A.D.), taught that holy men had no dreams, because they had been awakened from dreams (enlightened). No more sacred dreams, and this dream about "nothing" came to them only after years of diligent religious work. Although Fujiyoshi did not elaborate on these earlier opposing views on dreams in his special lecture, a common feature of these views could be regarded as extraordinarily modern and in accord with some contemporary theory on dreams. The contents of the quoted dreams, both sacred dreams and dreams about "nothing," were the result of years of intense meditation and religious devotion. Zendo and Suzuki Shosan showed that dreams might be brightened and reshaped. They suggested that conscious control of dreams was possible and dreams could, in turn, change the state of mind for the next day, or possibly over a much longer time. The control of dreams, to be happier and healthier mentally, has been pursued by Rosalind D. Cartwright and others from a Western perspective (1).

HISTORY OF THE INTERNATIONAL CONGRESS OF SLEEP RESEARCH

To place the Tokyo Congress in its proper perspective, a brief history of the International Congresses of Sleep Research would be useful. The first congress, attended by nearly 500 persons, was held in Bruges, Belgium, June 19-23, 1971. This meeting also served as the 11th annual meeting of the APSS. The congress was honored by the presence of the Queen of Belgium at the inaugural session. Abstracts of the papers were published (2). Symposia were issued in a single volume in 1972 as "The Sleeping Brain," edited by M. Chase and published by the Brain Information Service (BIS) at the University of California, Los Angeles (UCLA). In the introduction, Frederic Bremer remarked that this congress set "the date when sleep research became a discipline unto itself."

The second congress was held in Edinburgh, Scotland, June 30-July 4, 1975, and served as the 15th annual meeting of the APSS. Four hundred participants from 23 countries were at Edinburgh and almost 290 topics about sleep and dreams were covered. There were four symposia:

ultradian rhythms,
growth, nutrition, and sleep,
brain stem neurobiology, and
the adaptive functions of sleep.

Four workshops were held:

endocrinology,
psychophysiology of dreaming,
insomnia and its treatment, and
nature and nurture of sleep.

The abstracts were published (3).

HISTORY OF THE JAPANESE SLEEP RESEARCH ORGANIZATION

How did the Japanese sleep research organization grow so rapidly and large enough to bear the burdens of hosting an international congress? Although the first Japanese study on sleep by Y. Fujikawa about "Concept of Sleep (Suimin no Gainen)" appeared early in 1902 (4), sleep research as we now know it started relatively recently in Japan. Japanese researchers such as Shimazono, Okuma, Hirai, Torii, Yamaguchi, and Fujisawa have been publishing their works in English since the 1950s. These same individuals, along with others, hosted the third international congress.

A cursory check of the congress program organizers show the names of authors who wrote popularized books on sleep in Japanese. The honorary president of the congress, Katsumi Kaketa, wrote a book, "Sleeping and Dreaming (Nemuri to Yume)," more than 20 years ago. Another popularized book on sleep was written by Junji Matsumoto, vice president of the congress, and a one-time co-worker of Michel Jouvet of Lyon, France (5). Einosuke Koga, a member of the local organizing committee of the congress, wrote a book on short and efficient sleep in 1957 (5). Reading these popularized books, together with Otoya Miyagi's "Dreams (Yume)" and Kazuo Asahina's "Physiology of Sleep (Nemuri no Seirigaku)," the Japanese public has been well informed about sleep from the very beginning. The United States similarly has its pioneering sleep researchers who have written books for the general public on such enjoyable texts as "The Gentle Tyrant" and "Some Must Watch While Some Must Sleep." (5)

My personal contact with some of the Japanese sleep researchers started in 1972 when I was introduced to Tomio Hirai and Kazuo Azumi through the late Shinkuro Iwahara, then at the Tokyo University of Education. This was a time when the XXth International Congress of Psychology was in its planning stage, and they were in charge of organizing a review session, "Psychophysiology of Paradoxical Sleep" (held on August 14, 1972, in Tokyo as a part of the Psychology Congress). William C. Dement and Kiyoshi Fujisawa were the main speakers, and Kazuo Azumi, Tadao Hori, and I were designated discussants. Dement discussed "Brain and Mind: Are They Related during REM Sleep" and Kiyoshi Fujisawa covered "Dreaming in the REM Sleep and the Effects of REM Deprivation." Dement amplified his scanning hypothesis, explaining that bursts of Rapid Eye Movements during REM sleep reflected looking (scanning) at some visual images seen in the dream. To substantiate this hypothesis, Dement compared the similarities of eye movements during REM sleep with those observed during the wake period when the eyes were actively scanning obejcts (6). Fujisawa reported that interruptions of REM sleep by awakening the sleeping subjects or query them about their dreams did not change the overall percentage of dream recalls, and that the amplitude of auditory-evoked potentials during REM sleep was reduced during recovery sleep after three consecutive nights of REM deprivation.

Encouraged by the surging research interest in sleep in the United States and Europe, Kazuo Azumi organized the sleep research group in Japan. This group held its first scientific meeting at Osaka University on December 2, 1973. The topic of this first meeting, chaired by Junji Matsumoto, was "Monoamines and sleep mechanisms." Since then, this group has convened two scientific meetings a year, drawing 50-60 participants. The

eighth and last meeting was held on May 21, 1977, to discuss automatic analysis of the sleep polygrams, and was chaired by Einosuke Koga. Around this time, the APSS membership spoke of holding the next international congress in Japan. The requirement for a formally chartered organization of the Japanese sleep researchers to cope with planning the congress was recognized. The result was that the original sleep group became the JSSR. The JSSR held its first meeting on December 3, 1977, at the Toranomon Kyosai Kaikan, Tokyo. As of November 1977, it had 127 members. The JSSR is managed by a group of 17 council members with Yasuo Shimazono as president. The details of the first meeting of the JSSR as well as abstracts of papers presented at the meeting of the original sleep research group in Japan were published in the journal, *Sleeping and Waking* (7).

REVIEW OF THE THIRD CONGRESS OF SLEEP RESEARCH

The congress had four symposia: There were:

1) Cerebral Mechanisms of Sleep (chairmen: J. Allan Hobson and Shizuo Torii; participants: M. Steriade, Yoshio Nakamura, Scott H. Chandler, Michael H. Chase, T. Oshima, Robert W. McCarley),
2) Human Sleep as a Biological Rhythm (chairmen: Daniel F. Kripke and Shiro Endo; participants: Daniel F. Kripke, Shiro Endo, Elliot D. Weitzman, Charles A. Czeiler, Martin C. Moore-Ede, Hartmut Schulz, Jurgen Zulley, Ken I. Hume),
3) Automatic Analysis of Sleep Polygram: Methodology and Application (Chairmen: Paul Naitoh and Eisnosuke Koga; participants: J. R. Smith, Shikio Inubushi, Shizuo Torii, Einosuke Koga, Rolf R. Engel, H. Hiraga, S. Ichijo, T. Okuma, Kiyoshi Fujisawa), and
4) Oscillators and Synchronizers of the Sleep-Waking Rhythm (chairmen: Hiroshi Kawamura and Friedrich K. Stephan; participants: Friedrich K. Stephan, Jennifer M. Swann, Cheryl L. Sisk, Shinichi T. Inouye, Itsuko Nihonmatsu, Hiroshi Kawamura, Nobuo Ibuka, A. A. Borbély).

Four workshops consisted of:

1) The Sleeping Pill: Evaluation, New Methodologies, Use and Abuse (chairmen: Ernest Hartmann and Teruo Okuma; participants: Ernest Hartmann, Teruo Okuma, Ian Oswald, John Thornby, Thomas Roth, Kazuo Azumi, Shuichiro Shirakawa, Nagatoshi Ohama, Mitsugu Oguri, Ian Hindmarch),
2) Recent Progress in the Study of Sleep Disorders (chairmen: Christian Guilleminault and Yasuo Hishikawa; participants: R. Broughton, Q. Ghanem, Y. Hishikawa, Y. Sugita, S. Nevsimalova, B. Roth, C. Guilleminault, Yoshio Teshima, Susami Ijiima, Katsuyuki Tanaka, Mitsuo Tachibana, Michel Billiard),
3) Recent Advances in Neuroendocrinology of Sleep (chairmen: Elliot D. Weitzman and Yasuro Takahashi; participants: Yuruzu Kato, Kazuo Chihara, Hiroo Imura, Sheldon Kapen, H.-J. Quabbe, M. Fregor, C. Bumke-Vogt, D. Gianella, Yasuro Takahashi, Kiyohisa Takahashi, Rene Drucker-Colin, Uzi Weinberg, Elliot D. Weitzman), and
4) Present and Future Directions of Sleep Research (chairmen: Ismet Karacan and Junji Matsumoto; participants: Michel Jouvet, Jean-Pierre Sastre, Kazuya Sakai (absent), W. C. Dement, U. J. Jovanovich (absent), Ismet Karacan, Junji Matsumoto).

There were over 300 individual papers scheduled at the congress. An examination revealed the following five major research areas to be of significance in current sleep research. They are:

research on sleep disorders,
biological rhythms and sleep,
automatic analyses of sleep data,
sleep-inducing substances, and
sleep deprivation.

Before descriptions of these areas are given, a few concepts and acronyms should be explained so as to improve the discussion on various aspects of sleep. Some concepts and acronyms appeared often in the congress. Others did not, but they were so unique that they are worthy of special mention. Human sleep is usually

classified into five stages: 1, 2, 3, 4, and Rapid Eye Movement (REM) sleep. Sometimes, sleep is divided into two states: REM sleep and non-REM (NREM) sleep. NREM sleep is a combination of stages 1, 2, 3, and 4. Stages 3 and 4 are occasionally combined and called Slow Wave Sleep (SWS). The REM refers, occasionally to the rapid movements of the eye themselves, not of REM stage. EDS stands for Excessive Daytime Sleepiness, a hallmark of sleep disorders. MSLT is a technique developed at Stanford University, and it stands for Multiple Sleep Latency Test for the EDS. The subjects or patients are given an opportunity to sleep during a 20-minute period every two hours. If they manage to sleep during this 20-minute period, they are awakened after one minute of sleep; this particular 20-minute test is over, until the next one comes along in two hours. The subjects or patients are awakened only after one minute of sleep so that sleep taken during the test would not lessen sleep tendency during the next test period. If they do not fall asleep, they are still tested for the full 20 minutes before the test is over. The MSLT is a powerful procedure which examines sleepiness objectively, and complements observations obtained with the SSS (Stanford Sleepiness Scale), a paper-and-pencil subjective rating of sleepiness. SAS represents Sleep Apnea Syndrome. Sleep apnea is a difficulty in breathing due to air-flow obstruction or to regulatory problems in respiratory centers in the nervous system, characterized by stoppage of air-flows for 10 seconds or longer during sleep. DPSP is a term used by Weitzman and his group to represent Delayed Sleep Phase Syndrome, a sleep disorder where patients cannot sleep until 3 AM to 6 PM (that is, their sleep phase is delayed), and they will be asleep until 10 AM to 3 PM, or they will be awakened in the morning, very tired and sleepy.

RESEARCH ON SLEEP DISORDERS

Sixty-one papers in the congress discussed primary sleep disorders. An additional 39 papers reported on sleep disorders secondary to other medical problems such as myotonic dystrophy, myxeodema, obesity, Parkinson's disease, epilepsy, alcoholism, schizophrenia, rheumatoid arthritis, tetanus, acromegaly, depression, and others. The total scheduled number of presentations was 323, and about 30% of the congress reports were related to sleep disorders. Borrowing from W. B. Webb, the congress spent a good deal of time on "doing sleep" rather than on "learning (about) sleep."

The congress reflected the fact that sleep disorders have become a major interest in sleep research. In 1977, the Association of Sleep Disorders (ASDC) adopted its guidelines and certification standards for sleep disorder centers. As of April 2, 1979, 31 centers for sleep disorders had been established in the United States and Canada, according to W. C. Dement, the ASDC president.

Three papers reported on the sleep disorders of patients most often seen in clinics by examining a consecutive series of 100 patients. Johann van den Hoed and others at Stanford University School of Medicine observed that, for 100 patients complaining of EDS (sleep apnea patients were not included in this series), 46 cases were diagnosed as narcoleptics, 17 as idiopathic central nervous system hypersomnia, and the others as EDS with a variety of causes; for example, five cases of EDS associated with "irregular sleep-wake pattern." Susan Montauk and others at the Cincinnati General Hospital reported a consecutive series of 100 patients complaining of sleep disorders and seeking treatment. Forty-two cases (42%) were found to suffer from EDS, 27 from insomnia, 14 from parasomnia, eight from miscellaneous causes, three from "nonrestorative sleep," and six from no obvious sleep disorder. A further breakdown of 42 EDS cases showed 18 cases were narcoleptics, 14 sleep apneas, seven nocturnal myoclonus, and two depressions. "Parasomnia" refers to cases of somnambulism, snoring, and sleep paralysis. P. Piccione and others at the Henry Ford Hospital in Detroit reported on another consecutive series of 100 patients complaining of sleep problems. They used the diagnostic nomenclature developed by the nosology committee of the ASDC. By means of the typical polysomnigraphic test and the MSLT, 40 patients were diagnosed to have insomnia with varied causes such as sleep apnea, drug-alcohol uses, nocturnal myoclonus and restless leg syndromes. Forty-two cases exhibited EDS. A further breakdown of EDS cases revealed 15 patients suffering from sleep apnea, four patients from nocturnal myoclonus, 17 from narcolepsy, two from idiopathic central nervous system hypersomnolence, and four from "insufficient" sleep. Three patients, all male, were diagnosed to have dyssomnia due to irregular sleep-wake patterns. Four cases had parasomnia. Eleven patients were found free of any sleep disorders.

Advancements in treatment of sleep disorders demand the cooperation of human patients as willing

experimental subjects for pre-clinical drug trials. However, it would be difficult to try our new drugs repeatedly on sleep disordered patients, as they are not "guinea pigs." Normal sleepers could not be used to test hypnotics, as they have short-sleep latencies and very few awakenings during sleep. Teruo Okuma developed a method for artificially creating transient insomnia in normal human sleepers for the purpose of evaluating new hypnotics. Volunteer normal sleepers were subjected to both intermittent white noise at about 90 phones and 10 mg of methylphenidate (MPD). A combined use of noise and MPD did create insomnia which could be relieved by hypnotics of known potency in a predictable manner. Toshio Ohta and others from the Sleep Disorders Clinic of Tokyo University Hospital reported that long-term prognosis of narcolepsy was not pessimistic because complete remission of narcoleptic symptoms was seen in 13% of the cases surveyed. Regarding insomniacs, M. Kramer and T. Roth noted that subjective and objective quality of sleep should be examined, because insomniacs' self-rating of sleep experiences was usually quite different from their objective sleep. Guilleminault observed that sleep apnea patients, as well as those patients who were hospitalized for various pathologies unrelated to sleep disorders, showed a worsening of cardiovascular functions during REM sleep, and he wondered if REM sleep was dangerous to their immediate health. REM sleep recurs regularly during sleep, and it can not easily be avoided in sleep. The threat posed by REM sleep for these patients unfortunately may be a real one. Yasuo Hishikawa and his associates explored the sleep of alcoholics during an acute withdrawal phase with delirium tremens (DTs). They found that sleep during DTs was characterized by an absence of SWS and a REM-like state, but with a tonic, elevated electromyographic level. Thus, alcholics in an acute withdrawal phase, did not have an increase in REM sleep, as previously believed. Instead, they had an increase of rapid eye movements, and they remained in a new state which was neither REM nor SWS. Hishikawa and others cautioned, therefore, that the hypothesis about DTs being intrusions of REM (dreaming) sleep into the wake phase was probably incorrect. Kazuo Azumi and his colleagues noted significant and consistent increases in sleep spindles in response to an intake of effective hypnotics derived from benzodiazepines as well as other hypnotics (such as methaqualone and glutethimide), and proposed to use the concept of "sleep spindle enhancing drugs" in future objective ratings of substances for hypnotic potency. Ismet Karacan and others continue to study nocturnal penile tumescence and have applied the findings to problems of differential diagnosis of impotence. F. Halperin and his associates reported that 91% of 22 adult cases, diagnosed with the hypersomnia-sleep apnea syndrome, at least 30 apneas with a minimum of 10 seconds' duration during a seven-hour sleep showed some oropharyngeal anatomical anomalies. Protriptyline was said to reduce the frequency of apneas and also to reduce the mean duration of apneas according to W. Conway and others, J. G. Fisher, and Augustin de la Pena. Tracheostomy was also successfully used for treatment of sleep apnea. T. Roth stated that tracheostomy skin flaps have been most successful in treating some apnea patients. The treatment with tracheostomy resulted in dramatic resolution of hypoventilation, arrhythmia, cor pulmonale, and EDS.

BIOLOGICAL RHYTHMS AND SLEEP

Sleep recurs every day, and within sleep, REM sleep reoccurs every 90 minutes. How does REM sleep recur so regularly in man and animals? Robert W. McCarley and J. Allan Hobson proposed the well-known "reciprocal interaction" theory to explain REM-NREM cycle. The periodic recurrence of REM sleep is the result of interaction between the inhibitory biogenic containing neurons in the locus coeruleus and the excitatory cholinergic and cholinoceptive neurons of the gigantocellular tegmental field (FTG) portion of the pontine reticular formation. To McCarley, Hobson and their group, the pontine mechanisms are necessary and sufficient for the basic periodic recurrence of REM sleep. This theory has been a departure from the pioneering work of Jouvet, who proposed the monoamine theory. As Shizuo Torii pointed out, sleep researchers are now charged with the task of re-examining Jouvet's theory. Kripke and his colleagues mentioned that the circadian cycle disorders were associated with affective diseases. Lithium carbonate was observed to delay the sleep-wakefulness cycle. In normal subjects, the therapeutic level of 1.0 meq./L of lithium was found to delay the sleep-wakefulness cycle by 13 minutes. This small, but reliable, delaying effect was of therapeutic importance for depressives because it could improve phasing with the photoperiodicity of day and night. Shiro Endo and his associates found that REM sleep was circadian, but SWS was independent of the circadian rhythm and dependent more on the hours of prior wakefulness. Akio Miyashita and his colleagues observed that autonomic activity of skin potential response was circadian, and that it was not exclusively associated with SWS. Masaru Kobayashi found the myoelectrical activity of the cat's stomach was directly influenced by the volume of the meal

remaining in it, and had no relation to the sleep-wakefulness cycle. Toke Hoppenbrouwer and her colleagues observed the emergence of circadian patterns in heart rate and the night-time distribution of sleep states during the first six months of human life. The NREM-REM cycle coes not appear to change with aging. R. Spiegel compared NREM-REM cycle of young males with two groups of older people: one group, 53-70 years of age, and the other 83-93 years of age. The 83-93-year-old group had severe deteriorations. Weitzman and Czeisler reported on the application of "chronotherapy" to sleep disorders. Weitzman reported that 10% of 45 patients with primary complaints of insomnia had DSPS, causing sleep onset insomnia. They fell asleep between 3 and 6 AM, waking up, if undisturbed, between 10 AM and 3 PM. The patients with DSPS could not advance sleep time (sleep earlier in night), however, they tried, whereas they could delay time for sleep. Czeisler and others proposed chronotherapy where patients lived under a 27-hour/day regimen, delaying bedtime by three hours every night until they were "rotated around the clock" to a preselected ideal time.

The role of the suprachiasmatic nucleus (the SCN) as a Zeitgeber was discussed at the congress by Stephen and others, Inouye et al., and Nobuo Ibuka. Stephen proposed that the SCN was not the sole Zeitgeber for the sleep-wakefulness cycle, and hypothesized that a Zeitgeber could be found in feeding cues. By feeding regularly within the circadian range, Stephen and others successfully maintained the sleep-wakefulness cycle in the SCN-lesioned rats. Shin-ichi Inouye showed that the SCN is an autonomous circadian rhythm generator in mice (11). Masako Okawa and her associates used computed axial tomography of acerebrate patients, and found that the brain stem played a more important role than the cerebral hemispheres in controlling circadian rhythms in sleep-wakefulness, body temperature, and plasma cortisol.

AUTOMATIC ANALYSES OF SLEEP DATA

Twenty-nine papers were concerned primarily with quantification and analysis of sleep data. The most noteworthy effort was Einosuke Koga's preparation of a bibliography on Japanese studies of the automatic analysis of sleep data, starting with a 1953 paper by Shirai and Shibuya. His bibliography contained 44 references, most of which are available only in Japanese. One could not help wonder about the possible impact on sleep research if these papers were published in English.

Sleep data consist of all-night continuous recording of multichannel electroencephalograms, eye movements, electromyogram of the chin, and many other activities. Because of this length, analyses of sleep data have been very time-consuming. The drudgery of manual page-by-page sleep-staging of 1,000-page sleep records has stimulated computer analyses. A microcomputer-based sleep analysis machine developed by Einosuke Koga and his associates was exhibited at the congress. It promises a great future not only for sleep-staging, but also for analysis of sleep phenomena not encumbered by the concept of sleep stages. Three automatic sleep analysis systems, independently designed by Jack Smith, Rolf Engel, and H. Hiraga, were discussed at the symposium on automatic analysis of the sleep polygram. These systems were found to mimic human scorers well enough to replace them. At the APSS meeting of 1978, a sleep-scoring system designed by J. M. Gaillard was found good enough to replace human scorers. The difficulty has been in promoting wider acceptance of already available machines. The low-acceptance rate of the automatic sleep analyzers can be explained by the fact that there are so many systems to choose from. Guidelines for choosing one system over others are not available. An absence of guidelines and certification procedures has been discouraging to designers.

The current design principle for sleep analyzers has been to use many special waveform detectors, e.g., for sleep spindles, eye movements, brain wave alpha and delta, body movements, and others. The outputs of these detectors are used not only for sleep-staging, but also as physiological measures of sleep independent of sleep stages. Ron Harper pointed out the importance of this analysis, because sleep clinicians often face circumstances where the concept of sleep stages is no longer helpful. Dement was puzzled by the strong emphasis on sleep-staging according to the arbitrary criteria of Rechtschaffen and Kales. He was disappointed not to see the sleep-scoring machine put to greater use.

One of the strong interests has been automatic analysis of sleep spindles. Kazuo Azumi and his group, Kenji Matsubayashi, and Mitsuru Ebe and his group reported on automatic spindle detectors and their applications.

Few papers reported on coherence measures of sleep brainwaves. Coherence is a mathematical measure of similarity of two waveforms over time. A group headed by Yoichi Saito described "extended coherence analysis." Dietrich Lehmann and his colleagues found high coherence between the left and right hemispheres at the precentral and parietal regions during REM sleep in humans. Their results were in curious contrast to the low coherence found by Kiyoshi Fujisawa and his associates between the anterior and posterior central electroencephalograms during REM sleep. These two studies revealed intricate changes in the electrical structure of the brain during REM sleep. Dietrich Lehmann observed that the bilateral coherence during stage 1 was significantly lower than that during REM sleep. If confirmed, this would be very exciting news for designers of automatic sleep-staging machines, because bilateral coherence might aid in discriminating stage REM sleep from stage 1.

Shikio Inubushi and his colleagues developed an automatic sleep-staging system for cats. Their system did not use the sensory motor rhythms (SMR) of M. B. Sterman. The SMR was, however, extensively used in the new recording and scoring manual for cats prepared in time for the congress by Reidun Ursin and M. B. Sterman. It would be interesting to see how the SMR would be handled by the designers of sleep-staging machines for cats in the future.

Cine-analysis of body movements during REM sleep in cats was described by Michael Biber. J. Allan Hobson reported on a time-lapse photography method to study the sleep-wakefulness pattern of a married couple, where the couple was photographed every 14 minutes for three and a half consecutives days. This cine-analysis method opened up research on the ethology of sleep. This method is inexpensive and non-invasive. This study of life (sleep and wake time) of a married couple was not supported by grant funds. Perhaps a really innovative study would come out of non-funded research, unencumbered by grant requirements.

SLEEP-INDUCING SUBSTANCES

Henri Pieron speculated in his classic book, "Le Problème Physiologique de Sommeil" (Masson, Paris, 1913), that a substance was accumulated in wakefulness, which was eliminated during sleep. Since then, attempts to find hypnogenic substances have continued. Currently, the search for sleep-inducing endogenous substances is being pursued by four groups:

1) John R. Pappenheimer and his group in Boston, trying to identify "the sleep-promoting factor,"
2) M. Monnier and his group in Zurich, attempting to identify the DSIP (Delta Sleep-Inducing nonaPeptide),
3) Koji Uchizono and Hiroaki Nagasaki in Okazaki and Tokyo, respectively, searching for sleep-promoting substance," and
4) Renè Drucker-Colin in Mexico City, studying brain perfusates and specific protein synthesized to regulate REM sleep at the onset.

All attended the congress, except John R. Pappenheimer. Other researchers also participated in discussion of sleep-inducing substances. G. Stock and others from Heidelberg discussed gammahydroxybutyrate (GHBA–endogenously occurring metabolite of GABA in cats). M. R. Dzoljic of Rotterdam discussed D-ala^2-methionine enkephaline amide (DALA), one of the brain hormones. Nobuyuki Okudaira reported on 1-methylheptyl-gamma-bromo-acetoacetate (gamma-Br).

The sleep-inducing factor of Pappenheimer is a polypeptide with molecular weight of 350-500; the effective dose is a few picomols per gram brain. Its full amino-acid sequence is yet to be determined (12). M. Monnier's DSIP is nonapeptide with the sequence of Try-Ala-Gly-Asp-Ala-Ser-Gly-Glu with molecular weight of 848.98. J. M. Gaillard and M. Monnier found that a synthetic DSIP developed a hypnotic effect in rabbits and cats after ventricular or intravenous injection. It required a minute quantity of 30-40 nmols/kg of body weight to increase significantly total sleep duration, its effects starting one hour after intravenous injection. Uchizono, Nagasaki, and Inoue compared DSIP with their sleep-promoting substance extracted from the brain stem of sleep-deprived rats (i.e., Brain Extract–Sleep-Deprived Rats, BE-SDR) in mice, and found that both DSIP and BE-SDR triggered the sleep cycle. Inoue administered the sleep-promoting substance of Uchizono and others by intracerebroventricular

injection from 10 hours. This procedure resulted in SWS increase by 50-100% and decreased locomotor activity by 30-70% in chronically cannulated rats. Clearly, at this time, we do not have the final word about the sleep-inducing substances. Recently, Koji Uchizono has published on his search for the sleep-promoting substance in a popularized book, "Search for the Essence of Sleep (Nemuri no Sei o Sagaru)" (Tamagawa University Press, 1976). This book, in Japanese, contains an overview on past efforts of many sleep researchers delving into the essence of sleep, including a historical sketch of how Bromo substance came to be studied by Yanagisawa, Torii, and then Okudaira. The book also describes the use of the abdominal ganglion of crayfish as a method of bioassay for potency of sleep-promoting substances.

SLEEP DEPRIVATION

It seemed that fewer and fewer researchers can be found in this area. However, a closer look into sleep research reveals that sleep deprivation has become a tool of sleep research. Naohiki Yamaguchi and his colleagues deprived 47 endogenous depressive patients of one night's sleep. They observed that total sleep deprivation normalized circadian rhythms of plasma cortisol among those depressives who were benefited by it. Hisashi Kumashiro and others studied circadian rhythms of plasma cycle AMP during total sleep deprivation in normal and depressive patients. For normal subjects, a clear circadian cycle was observed, both during the baseline and total sleep deprivation periods, but depressive patients had poorly developed circadian rhythms during the baseline period, and with total sleep deprivation, there rhythms were normalized. Hiroaki Hasuzawa, Yoichi Nakazawa, and their associates made the curious finding that oral administration of single dose of 200 mg L-5HTP, 30 minutes before going to bed, did not change normal sleep stages, but it eliminated SWS rebound expected in those individuals who were totally sleep-deprived and then allowed to have a recovery sleep. The authors believed that SWS was involved in producing 5-HT (serotonin). The same group previously made a similarly curious finding that an administration of 1 gram of L-DOPA eliminated REM rebound expected during the recovery night, after partial deprivation of REM sleep. The authors believed that REM sleep was involved in production of norepinephrine (13). Marilyn Glenville's study showed that youth, greater height, and a high degree of interest in physical activity were the advantageous characteristics of individuals to withstand effects of total sleep deprivation. A. J. Spielman conducted REM deprivation of narcoleptic patients to find that a great number of REM awakenings was needed to deprive REM sleep from the narcoleptics. They showed no REM rebound. These observations led to an interpretation that narcoleptics were unable to accumulate REM sleep need.

CONCLUSIONS

Many other important topics discussed at the congress, such as pharmacology, neuroendocrinology, basic physiology, and sudden infant death syndrome (SIDS, commonly known as "crib death") are not reviewed in this report, as they are too complex to be properly evaluated. Even the simple problem of pharmacology to develop a hypnotic has turned out to be rather complex. So many hypnotics are already available. Ernest Hartmann pointed out that we lack "more rational approaches in developing sleeping pills." He wondered if some endogenous (naturally occurring in our body, especially in our brain) substances such as dopamine blockers, brain peptides, serotonin, and its precursors could be developed as more rational hypnotics. As one of the naturally occurring substances, L-tryptophan seemed to be a good candidate for safe and effective hypnotics. But there was a disagreement in the congress between Hartmann and his associates and Kirstine Adam and Ian Oswald (9) as to a hypnotic potency of 1 gram of L-tryptophan. Another crucial but complex development was in proposed changes of procedure to evaluate hypnotic potency. Dement and his group appeared to break away from the traditional view that effectiveness of hypnotics could be evaluated by some improvement in sleep, assuming that changes in sleep are sufficient to prove their usefulness. Dement and his group showed that daytime effectiveness should also be considered in evaluation of hypnotics. Hypnotics should not only improve sleep but, more importantly, improve an individual's life style.

What is the future of sleep research? In the workshop of the congress, Michel Jouvet, William C. Dement, Ismet Karacan, and Junji Matsumoto addressed the future of sleep research. The future described by each of these speakers was quite individualistic and predictable on the basis of what each has achieved in sleep research. An unexpected future view was given by Michel Jouvet, who stressed the need of ethology of dreaming among

the cultural isolates in the jungle before we lose their uncontaminated dreams. Perhaps we should not forget the importance of the study of dreams, the most familiar and yet mysterious experience in our life.

Readers interested in more details of the congress should consult the abstracts, which will appear as Volume 8 of *Sleep Research,* to be published by the Brain Information Service (BIS), University of California, Los Angeles.

Table 1

Number of Participants in the Third International Congress of Sleep Research by Countries

Japan	333	Romania	1
U.S.	53	Bulgaria	2
Canada	11	Czechoslovakia	1
Switzerland	7	Israel	2
West Germany	14	Italy	6
F. R. Germany	1	India	1
France	19	The Netherlands	2
Australia	4	Austria	1
Uruguay	1	Korea	7
Mexico	3	South Africa	1
Scotland	2	Belgium	2
England	4	Yugoslavia	2
Ireland	1	Philippines	1*
Sweden	1	Nigeria	2**

Total number of participants: 485. This information was provided by Dr. Hideo Sasaki and the Third International Congress Sleep Research.

* = c/o Dr. Masataka Hayashi.

** = c/o Dr. Shojiro Inoue.

REFERENCES

1. R. D. Cartwright, "Night Life: Explorations in Dreaming." Prentice-Hall, 1977.
2. *Psychophysiology*, 9:84-153, 1972.
3. *Sleep Research*, Vol. 4. Brain Information Service (BIS), Univ. of California, Los Angeles, 1975.
4. Tomio Hirai, chapter from "Sleep (Suimin)." Igaku Shoin, 1971.
5. Katsumi Kaketa, "Sleep and Dreaming." Iwanami Shoten, 1957.
   Junji Matsumoto, "The Worlds of Sleep and Dreams (Nemuri to Yume no Sekai)." Tokyo Keizai Sha 1972.
   Eisaku Koga, "Short Sleep Methods (Tanjikan Suimin Ho)." Kobun Sha, 1963.
   W. B. Webb, "Sleep, the Gentle Tyrant." Prentice-Hall, 1975.
   W. C. Dement, "Some Must Watch While Some Must Sleep." W. H. Freeman, 1972.
   Otoya Miyagi, "Dreams (Yume)." Iwanami Shoten, 1953.
   Kazuo Asahina, "Physiology of Sleep (Nemuri no Seirigaku)." Chugai Igaku Sha, 1965.
6. Toshimasa Fukuda et al. Detailed comparisons of eye movements during REM sleep and alert period conducted during congress.
7. *Sleeping and Waking*, 1:109-113, 1976.
   Sleeping and Waking, 1:217-220, 1977.
   Sleeping and Waking, 1:327-328, 1977.
   Sleeping and Waking, 2:131-140, 1978 (Notes of the first meeting of JSSR.)
8. Yasuo Shimazone, JSSR and International Congress of Sleep Research. *Seishin Igaku*, 20, 441-443, 1978. (In Japanese)
9. Since l-tryptophan is an amino acid present in our food such as milk, canned tuna, enriched dried noodles, and others, it seemed quite safe to consume (although it tastes terrible). For the interested readers, Ernest Hartmann's book, "The Sleeping Pill," Yale University Press, 1978, is recommended.

10. M. Menaker, J. S. Takahashi, and A. Eskin, "The Physiology of Circadian Pacemaker." *Ann. Rev. Physiol*, 40:501-526, 1978.
11. It would be of interest to read the summary prepared by Franz Halberg, of a Naito Foundation symposium on "Biorhythm and Central Mechanism" held in Tokyo in 1978. *Waking and Sleeping*, 3:93-99, 1979.
12. Pappenheimer's study was partly supported by the Office of Naval Research. "The Sleep Factor," *Scientific American*, August 1976, 24-29.
13. Y. Nakazawa et al., "Effects of L-Dopa on Natural Sleep and on Rebound of REM Sleep." *Folia Psychiat. Jpn.*, 27:223-230, 1973.

THE YAMADA CONFERENCE III
THE 14TH INTERNATIONAL SYMPOSIUM ON FREE RADICALS

J. R. McDonald

The 14th International Symposium on Free Radicals was held near Sanda, Japan, on 3-7 September 1979, under sponsorship of the Yamada Science Foundation. The meeting site, the Seminar House of the Kwansei Gakuin University at Nishinomiya, was very comfortable and ideally suited for the symposium. An outstanding job of preparation by the local organizing committee was evident in the diversity of papers presented at the meeting, the truly international participation, the smooth way the sessions were conducted. Professors Ikuzo Tanaka, Eiji Hirota, and Shuji Saito were primarily responsible for the success of the meeting.

The conference attendance was limited to approximately 85 participants. This included more than 50 Japanese scientists and foreign participants from Belgium, Canada, England, Germany, India, and the United States. The large number of Japanese scientific presentations gave the foreign participants an expanded understanding of the breadth of scientific research being carried out in Japan. The quality and diversity of Japanese science is excellent and extensive. Japanese participation included contributions from university research groups, independent research organizations, industry, and government.

The Yamada Conference was dedicated to the memory of Dr. Herbert Broida of the University of California of Santa Barbara, whose illustrious career was prematurely ended by his accidental death in April, 1978. The first morning session was devoted to papers reviewing his career and scientific accomplishments. Arnold Bass, National Bureau of Standards (N.B.S.), reviewed Dr. Broida's accomplishments during "the Washington Years," from 1949 to 1963. His pioneering contributions in the fields of radical spectroscopy and radical chemistry were reviewed, including many historical slides from this period which revealed the excitement associated with the radicals program at N.B.S.

Katsumi Sakurai, University of Tokyo, followed with a discussion of Dr. Broida's research program during the late 1960's at Santa Barbara. The pioneering efforts of his group in the developing area of laser-induced fluorescence was discussed. This was a particularly interesting period because much of the instrumentation, including the laser sources, had to be fabricated by the researchers.

This presentation was followed by a paper by Robert Field (M.I.T.) on the excited state dynamics and spectroscopy of BaO. This talk began with "The Questions Unanswered" about this molecular system at the time of Dr. Broida's death. The talk was particularly relevant because much of the exploratory work in radical chemistry and spectroscopy of BaO was done by workers in Broida's group.

The Free Radical Conference was organized to stress several topics, including:

a) formation and detection of new free radicals;
b) dynamics of reactive species;
c) high-resolution spectroscopy of free radicals; and
d) development of new techniques applicable to the study of free radicals.

It is not the purpose of this report to review the presentations of the individual participants in the conference. Such an endeavor would be too extensive. The proceedings of the conference will be published

by the Yamada Science Foundation and will include the extended abstracts of the papers presented at the meeting. Information relating to the *Proceedings* of the conference may be obtained by writing to Professor Ikuzo Tanaka at the University of Tokyo. What follows is a brief review of the highlights of the meeting organized by the major topics stressed in the conference.

NEW MOLECULAR SPECIES

Considerable new spectroscopic information was presented on several radical systems. The following examples are representative and serve to illustrate the extensive new spectroscopic information presented.

- CH_3O New spectroscopic discoveries concerning this elusive species were the most extensive of those at the meeting. H. E. Hunziker (I.B.M.) presented gas phase absorption spectra. G. I. Inoue, et al., (National Institute for Environmental Studies, Japan) presented laser-induced fluorescence excitation spectra and excited state lifetime data. H. E. Radford (Harvard-Smithsonian) presented data relating to CH_3O detection by laser magnetic resonance.

- CF_2 The phosphorescence of the $^3B_1$ state of this radical was reported by S. Koda (University of Tokyo). The intercombination band emission determines the S_0-T_1 splitting of this species.

- PO_2 A new absorption system for this molecule was reported by R. D. Verma (University of New Brunswick).

- HNO Three papers were presented on this radical species relating to spectroscopic and dynamic properties of the $\tilde{A}, ^1A''$ state; R. N. Dixon, et al., (University of Bristol); K. Takagi, et al., (Institute of Molecular Sciences, Japan); and K. Obi, et al., (Tokyo Institute of Technology).

- C_2O Emission spectra, fluorescence excitation spectra and excited state dynamics of the system were presented by J. R. McDonald (N.R.L.).

- HCF & HCCl M. Kakimoto, et al., (Institute of Molecular Science, Japan) presented laser spectroscopy data relating to these carbenes.

HIGH RESOLUTION SPECTROSCOPY

New high-resolution spectroscopic studies of several systems were reported. The following examples are representative.

- PBr R. Colin (Universite de Libre-Bruxelles) presented spectropic data on the $b^1\Sigma^+ - X^3\Sigma^-$ transition of this new radical including rotational analyses of several bands.

- NaK R. Colin, et al., (Universite de Libre-Bruxelles). Beam Studies of the $^3\Sigma^+$ state were reported which yield evidence for two previously undiscovered states, $B^1\Sigma^+$ and $C^3\pi^1$.

- ClO_2 A. J. Merer (University of British Columbia) reported high-resolution electronic studies of these transition metal oxide systems.

- HN_2 D. A. Ramsey (N.R.C. Canada) reported that the absorption spectrum of NH_2 has been completely rephotographed and is in the process of being analyzed. New analyses will include levels to $v'' = 5$.

REACTION CHEMISTRY

There were several reports of studies of reaction chemistry including atom-molecule and radical reactions and a few reports on atmospheric-related chemistry studies. The following examples illustrate these studies.

- K. D. Bayes et al., (U.C.L.A.); alkyl radical oxidations studied by photoionization mass spectroscopy was discussed.

- H. Akimoto et al., (National Institute of Environmental Studies, Japan); ozone reactions with olefins were described.

- G. R. DeMare (Universite de Libre-Bruxelles); oxirane gas phase reactions measured in their laboratory were reported.

- T. Ohta et al., (Tokyo Metropolitan Research Laboratory of Public Health); t-Butyl radical reactions in NO-air mixtures were described in this evironmentally-related paper.

- S. Koda (University of Tokyo); the production of CF_2 was reported from the oxygen atom reaction,

$$C_2F_4 + O(^3P) \rightarrow CF_2 + OCF_2.$$

- H. Radford, et al., (Harvard-Smithsonian); CH_3O reactions, studied by LMR, were described.

- D. Gutman (I.I.T.); O atom addition reaction mechanism with a range of organic molecules was reviewed. Emphasis was placed on crossed-effusive beam-mass spectrometry, and laser and chemiluminence studies.

- S. Tsunashima, et al., (Tokyo Institute of Technology); condensed phase reaction of NH with alkanes were presented.

- N. Washida (National Institute of Environmental Studies, Japan); CH_3 reactions with $O(^3P)$, O_2, NO and CH_3 were discussed.

- J. R. McDonald (N.R.L.); C_2 ($X\ ^1\Sigma_g$ and $a^3\pi_u$) reactions with O_2 and aliphatic and unsaturated hydrocarbons were measured yielding the first absolute rate constants. In a similar work, C_2O ($X^3\Sigma^-$) reactions with NO, O_2 and hydrocarbons were reported.

- M. E. Jacox (N.B.S.); F atom reactions in matrices were presented in two presentations.

NEW TECHNIQUES FOR SPECTROSCOPIC STUDIES

The conference had one session devoted to the development of laser magnetic resonance spectroscopy, in which representatives of most of the laboratories studying this technique reviewed their research work. K. M. Evenson (N.B.S., Boulder) presented an invited paper covering the development of the field using far infrared lasers. Large amounts of data on numerous systems were presented. H. Radford (Harvard-Smithsonian) reported the use of a similar system in experiments designed to study CH_3O reaction kinetics. H. Uehara et al., (Sagami Chemical Research Center) reported LMR studies using a CO_2 laser source for the study of CO_2. H. Uehara, et al., (Sagami Chemical Research Center) reported CO and CO_2 laser studied by LMR of two transient radical systems, NSe and SeO. A. R. W. McKellar, et al., (N.R.C., Canada) reported LMR studies using CO and CO_2 lasers of numerous species including NO, $Hg(^3P)$, HCO, DCO, PH_2, ND_2, NH_2, HO_2, DO_2, and FO.

R. F. Curl, et al., (Rice University) presented an interesting paper in which he described the adaptation and use of an F-Center laser for the study of free radical spectroscopy. H. W. Kroto (University of Sussex), in an excellent paper, reported on the combined use of microwave spectroscopy.photoelectron spectroscopy, and radioastronomy techniques for the detection and characterization of many new and unstable species. J. R. McDonald (N.R.L.) described the use of vacuum ultraviolet excimer lasers to carry out multiphoton dissociation reactions to produce high concentrations of very energetic radicals. This technique is used to characterize

production dynamics of these species and, with the use of a second probe laser, the reaction kinetics of several important combustion reactions.

K. H. Welge (University of Bielefeld) reported on recent investigations of photodissociation processes of neutral molecules by state selective laser spectroscopy. Stimulated antistokes Raman-shifting techniques to produce tunable vuv radiation for probing were discussed. In addition, a technique called laser-induced fluorescence Doppler spectroscopy was described. This technique is used to measrue recoil energy and angular distributions of unimolecular photodissociation reactions.

Appendix 1

Addresses of Activities Involved in Yamada Conference III.

- Kwansei Gakuin University
  1-155, Ichiban-cho, Uegahara
  Nishinomiya, Hyogo 622
  Japan

- Sagami Chemical Research Center
  4-4-1, Nishi-Ohnuma
  Sagamihara, Kanagawa 229
  Japan

- Tokyo Institute of Technology
  2-12-1, Ohokayama
  Meguro-ku, Tokyo 152
  Japan

National Institute for Environmental Studies
Yamabe, Tsukuba
Ibaraki 300-21, Japan

Tokyo Metropolitan Research Laboratory of Public Health
3-24-1, Hyakunin-cho
Shinjuku-ku, Tokyo 160
Japan

University of Tokyo
7-3-1, Hongo
Bunkyo-ku, Toky 113
Japan

INTERNATIONAL CONFERENCE ON ELECTRONIC PROPERTIES OF TWO-DIMENSIONAL SYSTEMS

A. Isihara

As a person who has roots in Japan and is familar with Japanese research activities, I am pleased to report on the International Conference on Electronic Properties of Two-Dimensional Systems, which was held in Yamanaka, Japan, September 2-6, 1979. The conference is called Yamada conference in recognition of the generous financial support from Mr. Kiro Yamada, president of a Japanese pharmaceutical company and a father of a physics professor. It was the third international conference on the subject. The first conference was held at Brown University, and the second at Berchtesgaden near Munich, Germany, two years later.

To hold the third conference in Japan was meaningful to those Japanese who remembered that, exactly twenty years ago, the Japanese physicist, Akiyoshi Kobayashi, reported, at a conference at the University of Maryland, a dramatic increase in the conductivity of germanium due to changes in surface states. The increase was large enough to convince the audience that the study of two-dimensional electronic properties was important.

Professor S. Kawaji, chairman of the organizing committee, was a student of the late Professor Kobayashi. He is currently engaged in experiments on transport phenomena at Gakushuin University in Tokyo. The other committee members include Dr. L. Esaki of IBM and Professors T. Sugano and Y. Uemura of the University of Tokyo.

TWO-DIMENSIONAL SYSTEMS

It has been found that electrons can be confined in a narrow layer between the semiconductor and its oxide in the MOS (metal-oxide-semiconductor) device. The layer is called "inversion" when the charges of the electrons and of carriers in the bulk semiconductor are opposite in sign. If the signs are the same, the name "accumulation layer" is used. A typical MOS uses silicon and its oxide.

The electrons in such layers can move two-dimensionally, and their density, typically of the order of 10^{12} cm^{-2}, can be varied over a remarkably wide range. These two features make the study of these electrons very important. In contrast, the density of metallic electrons can not be changed much. Moreover, the MOS device has important industrial applications and, in fact, has been developed into the so-called MOSFET (metal-oxide-semiconductor-field-effect transistor).

Electrons can be trapped two-dimensionally on the surface of liquid helium by image forces. This two-dimensional system of electrons has the advantage of being free from impurities. On the other hand, the electron density is not very high. A typical density is 10^{8} cm^{-2}. Thus, the system is classical.

Another interesting two-dimensional system has been realized by artificially-made superlattices. By computerized molecular-beam epitaxy, one can make alternating thin layers of two semiconductors. The potentials between the layers form a one-dimensional array like the one in the Kronig-Penney model.

Superlattices of GaAs-GaAlAs or InAs-GaSb have been studied extensively. By letting, for instance, the electrons in GaAlAs migrate across the interface into GaAs, a strong electric field can be created. This field will bend the band near the interface, resulting in an electron confinement as in the case of inversion layers. Electron

concentration in these systems are of the order of 10^{12} cm^{-2}. Again, the electrons move freely in parallel with the interface.

CONFERENCE SESSIONS

The international conference was concerned with three two-dimensional systems. It attracted approximately 120 attendees, more than half of them from abroad, and consisted of the following sessions:

1. Opening Session

Three invited talks given by P. J. Stiles (Department of Physics, Brown University), C. C. Grimes (Bell Telephone Laboratories), L. L. Chang (T. J. Watson Research Center, IBM), and L. Esaki (T. J. Watson Research Center, IBM) summarized the experimental situations of the three systems discussed above. The observation of a classical electron lattice by Grimes was interesting to me personally. These three talks characterized the general nature of the conference.

2. Semiconductor Heterojunction Superlattices

The two-dimensional character of the electrons and subband splittings were demonstrated by the SdH oscillations and optical measurements, respectively. Calculations of the energy at the band edge were reported. Experiments on precisely-doped superlattices, including the width effect on the temperature dependence of the Hall mobility, were reported.

3. Valley Splittings

The conventional effective mass theory applied to Si/SiO_2 yields two-fold valley degeneracy in the direction of (001). The lifting of this degeneracy has been discussed for several years, but no satisfactory theory has yet been given. There are similar problems in other directions.

The valley splittings evaluated by F. J. Ohkawa-Y. Uemura (University of Tokyo) and by L. J. Sham-M. Nakayama (University of California at San Diego and Kyusyu University, respectively) have been found not to agree with the experiment. Various theoretical and experimental considerations were presented. An attempt which does not use the effective mass theory was presented. The lineshape of the SdH oscillations, on which the splittings are reflected, requires many-body treatments. On the experimental side, the cleanness of the interfaces is a key. Reductions in the valley splittings at finite temperatures were reported.

4. Electron-Electron Interactions and Plasmon

It was suggested that intervalley exchange and correlation may lower the valley degeneracy. Considerations of the subband structure in GaAs were given. In my talk, I pointed out that there is a fundamental problem in the theories which take only the exchange interactions into consideration, and that there is an important correlation through a logarithmic term between the temperature and magnetic field dependences of electron properties. The discovery of such a term is very important, because it could explain the general discrepancy between theory and experiment on the effective g factor and of mass at low density.

5. Electrons on Liquid Helium

P. Leiderer (Fachbereich Physik der Technischen Universität, München) showed a beautiful movie on the formation of a dimple electron lattice. V. B. Shikin (Institute of Solid State Physics, U.S.S.R. Academy of Sciences) also showed a similar movie in black and white. The talk by Grimes at the opening session was convincing. A microscopic theory of crystallization and melting should be developed, because there are enough theoretical estimates of the melting point.

6. Spectroscopy

Attempts at separating many-body effects from some other effects, and at finding the effects of oxide charges, etc., were discussed.

KYOTO INTERNATIONAL SUMMER INSTITUTE ON PHYSICS OF LOW-DIMENSIONAL SYSTEMS

The Kyoto Summer Institute, held September 8-12, 1979, was organized by Dr. Y. Nagaoka (Research Institute for Fundamental Physics, Kyoto University) and others, primarily for advanced graduate students. There were six lectures and several seminars. It was attended by approximately 90 students and scholars, including 15 from abroad. The titles of the review lectures were as follows:

- Theory of Melting, Liquid Crystals and Superfluidity in Two Dimensions
  B. I. Halperin
  Department of Physics
  Harvard University
- The Many-Body Problem in One Dimension
  V. J. Emery
- Quasi-Two Dimensional Electron System at the Semiconductor Interface
  L. J. Sham
  Department of Physics
  University of California at San Diego
- Wigner Solid in Two Dimensions
  H. Fukuyama
  Institute for Solid State Physics
  University of Tokyo
- Two Dimensional XY Model
  M. Suzuki
  Department of Physics
  University of Tokyo
- Disordered Planar Model in Two Dimensions
  J. V. Jose
  The James Frank Institute
  University of Chicago

My seminar was entitled "Statistical Mechanics of Low-Dimensional Systems." I discussed a theory of condensation in arbitrary dimensions, properties of two-dimensional electrons in strong magnetic fields, superfluid phenomena of liquid helium films, and phase transitions in liquid crystals in two dimensions.

In contrast to the Yamanaka Conference, the Kyoto meeting was entirely concentrated on condensed matter theory, even though some speakers reviewed experimental situations. It was held at Kyoto University in an informal atmosphere. It was organized as one of the efforts by the Research Institute for Fundamental Physics (Yukawa Hall) to promote international activities. Since it was held right after the Yamanaka Conference, it was very effective in allowing us to reconsider the subject of the two-dimensional electron systems from a somewhat wider theoretical point of view. However, only very few from the Yamanaka Conference attended the Kyoto meeting, presumably because of the theoretical character of the latter.

THE YAMADA CONFERENCE II ON ELECTRONIC PROPERTIES OF TWO-DIMENSIONAL SYSTEMS

R. J. Wagner and B. D. McCombe

The Third International Conference on the Electronic Properties of Two-Dimensional Systems was held at Hotel Mt. Fuji, Lake Yamanaka, Japan, September 3-6, 1979. This conference, sponsored by the Yamada Science Foundation, is the third in a series; previous conferences were held at Brown University, Providence, in 1975, and at Berchtesgaden, W. Germany, in 1977. It brought together condensed matter physicists interested in two types of physical systems where electrons can be confined in a quasi-two-dimensional (2D) manner: (1) electrons on the surface of cryogenic fluids, usually liquid He, and (2) electrons confined in space charge layers (either inversion or accumulation) in semiconductors. One hundred and thirteen scientists representing 12 countries attended the conference. This is roughly double the attendance and national representation of the first conference. As expected, the largest group of scientists was from Japan (44%) with the United States second (26%). There was also substantial representation from European countries and the U.S.S.R. The excellent foreign attendance was made possible, in part, by the generosity of the Yamada Foundation and the conference committee in providing financial assistance to foreign participants.

Although the majority (~85%) of the papers presented were concerned with semiconductor studies, the work related to electrons on the surface of liquid helium played an important role at the conference and included some of the most exciting new physics. In this system electrons are produced by a hot cathode and forced to the surface of the liquid helium by an electric field applied between the parallel metal electrodes of a capacitor arrangement, with one plate above and one below the surface of the liquid. Electrons reside just above the surface of the liquid helium (~ 80 Å) in a potential well formed by the weak long-range image potential (attractive) and strong short-range electron-helium atom repulsion, resulting from the Pauli exclusion principle. The surface of the helium is actually deformed in the vicinity of the electrons, forming "dimples" in which the electrons reside. Due to the potential well, electron motion perpendicular to the surface is quantized. The energy separation between the quantized levels can be Stark-tuned by the externally applied electric field. The areal density of electrons, n_s, can be varied between about 10^7 cm^{-2} and 10^9 cm^{-2}. The upper bound results from the compliance of the liquid helium surface; an instability sets in if the surface electron density exceeds $\sim 2 \times 10^9$ cm^{-2}. Various experiments over the past few years have shown that the electrons have exceptionally long scattering times. This indicates that the sytem is very "clean." That is, the electrons do not encounter the high density of scattering centers which typically are associated with semiconductor space charge layers. Another difference between the two systems lies in the electron kinetic energy distribution; classical (Boltzmann) statistics describe the low density of electrons on liquid helium, while quantum (Fermi-Dirac) statistics are required to describe the higher electron densities ($10^{10} - 10^{13}$ cm^{-3}) generally achievable in the semiconductor case.

One of the most interesting and controversial topics related to studies of the electronic properties of 2D systems in the past several years has been the possibility of creating (and observing) a 2D electron crystal as first suggested (for the 3D case) by Wigner in 1934. The basic idea underlying Wigner crystallization is straightforward: at relatively low-electron densities, such that the Coulomb energy is dominant over the kinetic energy, the total energy of a system of electrons can be minimized if the electrons arrange themselves in a regular lattice. For a 2D Fermi system (Fermi energy much larger than kT, where k is the Boltzmann constant and T is the temperature), as encountered in the semiconductor case, the kinetic energy per particle is proportional to n_s, while the Coulomb energy per particle (related to the average separation of electrons) is proportional to $n_s^{1/2}$. At sufficiently low density, the Coulomb energy term dominates. On the other hand, for a classical system such as electrons on the surface of liquid helium, the kinetic energy per particle is simply

proportional to kT, while the Coulomb energy is again proportional to $n_s^{1/2}$. In this case, the Coulomb energy dominates at sufficiently high density.

It appears that the first system found to undergo Wigner crystallization has been the classical and cleaner case of electrons on liquid helium. In an invited review talk by C. C. Grimes* and G. Adams (Bell Telephone Laboratories), the first observation of the electron crystal on the liquid He surface was described. By studying the radio frequency (2-40 MHz) excitation of coupled ripplon (capillary)-plasmon waves, Grimes and Adams have found that the electrons crystallize in a triangular lattice and that the crystal melts when the ratio of Coulomb energy to kinetic energy (Γ) is less than 131 ± 7.

No conclusive observation of crystallization has been reported for space charge layers in semiconductors, although some of the cyclotron resonance studies at low temperature and low density are suggestive of collective effects. This work is discussed below. In a later invited talk, B. Halperin* (Harvard) described recent theoretical work on the melting of a 2D electron crystal. Generally this work is based on the Kosterlitz-Thouless idea that melting occurs when there exists a small number of unpaired dislocations. From this idea, theoretical calculations have yielded estimates of Γ at the crystal melting point and the temperature dependent shear modulus of the crystal that are in good agreement with the experimental results.

An interesting short motion picture was presented by P. Leiderer* and M. Wanner (Technical University of Munich) which showed the formation of a macroscopic "dimple" crystal (lattice constant of about 4 mm) on liquid He. In this experiment, it was possible to obtain electron "bubbles" containing about 10^7 electrons per bubble. These bubbles and their associated He "dimples" tended to align in a macroscopic hexagonal array. M. S. Khaikan*, A. M. Trojanovsky and A. P. Volodin (Institute for Physical Problems, Moscow) described the motion of electrons not only on liquid ^{4}He and ^{3}He, but also on liquid and solid H and solid Ne. Both of the preceding experiments seemed to indicate that there is substantial flexibility available to the experimentalist interested in electrons on the surface of cryogenic liquids (and solids).

Studies of electrons in space charge layers of semiconductors also showed diversification, both in experimental technique and in semiconductor material. The invited talk by F. Koch* (Technical University of Munich) and various contributed talks pointed out that many semiconductors have now been shown to exhibit aspects of 2D electronic behavior. Although there was only a modest numerical increase in the number of talks concerned with semiconductors other than Si (14) at this conference by comparison to the previous conference (12), it appeared that these talks focused more sharply on the electronic properties of the space charge layer than before. This is indicative of improvements of technique for preparing suitable structures, as well as some improvements in experimental techniques for their investigation. Studies of space charge layers in semiconductor heterostructures are particularly noteworthy in this regard. For example, the invited review talk by L. L. Chang* and L. Esaki (I.B.M.) about InAs-GaSb superlattices reported the observation of a transition from semiconductor to semimetal carrier transport as the InAs layer thickness is increased. Similarly, in an invited talk by R. Dingle*, H. L. Störmer, A. C. Gossard and W. Wiegmann (B.T.L.), the modulated doping technique for introducing free electrons into GaAs/GaAlAs superlattices was discussed. These scientists demonstrated that a substantial increase in GaAs electron mobility could be achieved by introducing donors into only the GaAlAs layer. Both of these experiments represent substantial progress over the Berchtesgaden meeting.

Using GaAs/GaAlAs heterojunctions (or superlattices), both G. Abstreiter* (High Field Magnet Laboratory, Grenoble) and A Pinczuk, J. M. Worlock*, H. L. Störmer, R. Dingle, W. Wiegmann and A. C. Gossard (B.T.L.) have been able to perform resonant light-scattering experiments which showed the electric field subband energy levels. This technique can be used for GaAs/GaAlAs heterojunctions due to the fortuitous energy match between the GaAs energy gap (between the conduction band and the split-off valence band at the Brillouin zone center) and suitable laser sources. Conversely, this effect has not been seen in Si due to the lack of suitable light sources in the appropriate spectral region. Theoretical aspects of these problems were discussed in an invited paper by E.

*Denotes the speaker.

Burstein*, A. Pinczuk and D. L. Mills (University of Pennsylvania, B.T.L., and University of California, Irvine, respectively).

The advance of work on compound semiconductors is also apparent when contrasted with work on Si-based 2D systems. About half of the talks at this conference were concerned with Si-based systems. However, it seems that some vexing, persistent problems remain on these extensively studied systems. The initial technical talk of the conference was an invited review talk by P. J. Stiles* (Brown University) on the development of transport studies of the space charge layer in Si devices over the past 10 years. It is clear that considerable progress has been made over that time period; however, Stiles described some persistent and annoying problems. One particular example is the determination of the effective mass from the temperature dependence of Shubnikov-de Haas oscillations. Results on the density dependence vary from sample to sample, from laboratory to laboratory, and on a single sample as a function of oxide charge. These effects are not understood at present. While it did not seem that any clear unambiguous solutions were presented at this conference, a number of very useful talks illustrated the dimensions of the problems. The first of these talks was a special lecture by T. Sugano* (University of Tokyo) about the structural characteristics of the Si/SiO_2 transition region. By considering evidence from a number of techniques (Rutherford backscattering, Auger electron, x-ray photoelectron spectrometries and transmission electron microscopy), Sugano presented a composite model of the transition region. This model included a strained SiO_2 region, surface roughness caused by excessive SiO_2 growth along defects, Si clusters imbedded in the SiO_2, and, finally, non-registered Si^+, Si^{++} and Si^{+++}. While some of these structures may have a benign effect on electron transport in the 2D layer, others may plan an important role. Thus, differences in processing techniques between laboratories may result in differences in the results of studies of the inversion and accumulation layers in the different laboratories. One of the talks that illustrated this was an invited review talk by T. Ando (University of Tsukuba, Sakura) on valley splitting of electrons on (100) Si devices. In this orientation, the two equivalent light-mass valleys are lower in energy than the remaining four heavy-mass valleys. However, it has been known for some years from magneto-transport experiments that a splitting of the two valleys exist. A great deal of experimental work has gone into investigating this splitting (several contributed talks were presented at the conference). While the major portion of the talk was concerned with a review of alternate theoretical formulations of the valley splitting problem, Ando also presented some of his calculations regarding misorientation effects on the valley splitting. He calculated that for very modest misorientations of the surface from precisely (100) (i.e., 0.01-0.05°), very substantial differences of valley splitting result. Since process control of sample orientation cannot be this precise and since the SiO_2 growth may give rise to further misorientation, it does not seem surprising that there is disagreement among determinations of the valley splitting obtained at different laboratories. In fact, this effect raises serious questions as to the utility of further studies of valley splitting.

An invited review talk by D. C. Tsui* and G. Kaminsky (B.T.L.) illustrated a similar point for the case of (111) Si devices. In this case, researchers have found that, rather than the expected six-fold valley degeneracy, a two-fold valley degeneracy is observed, implying a splitting of the six-fold degeneracy by some mechanisms. Two mechanisms have been suggested: 1) inhomogeneous strain at the interface, and 2) a charge density wave coupling of the valleys in such a way as to produce a two-fold degenerate ground state. By using additional processing steps which are purported to minimize structural defects such as dislocations and stacking faults, Tsui and Kaminsky observed the anticipated six-fold valley degeneracy. These results underscore again the relation between structural effects and 2D electronic behavior, but the underlying mechanism is still an unsolved problem.

Finally, C. T. White and K. L. Ngai* (Naval Research Laboratory) presented theoretical results which demonstrated that one of the structural features, namely, strained Si bonds at the interface, can have a very profound effect on the electronic properties of 2D layers at low temperatures by producing localization centers.

The talks described above are illustrative of the growing understanding of the relation between structural and electronic properties. However, many of the talks concerning the Si/SiO_2 system have avoided the problems posed above, by studying sufficiently clean MOS structures at high electron densities. For example, in an invited review talk, T. Theis (I.B.M.) described the excitation of inversion layer 2D plasmons via a grating structure at the gate of Si/SiO_2 devices. Here, the precise character of the interface is not so immediately important, and

there appears to be good agreement between a simple theoretical formulation of the plasmon properties and the experimental results.

The final invited review talk, by E. Gornik*, R. Schwarz, and G. Lindemann (Technical University of Vienna) and D. C. Tsui (B.T.L.), was concerned with the technique of far infrared optical emission spectroscopy as applied to space charge layer studies. In this experiment, electrically pulsing the conducting channel heats the electrons and causes an increase in the electron population in the excited states of the particular quantized levels under investigation. Although the process is not extremely efficient, some electrons relax via photon emission. For the case of electric field subbands, the wavelength of emissions give the subband energy separation. Gornik described how this technique has been used to study a variety of phenomena including cyclotron resonance, minigaps in vicinal planes of (100) Si, i.e., surface planes near the (100) direction, and plasmons and space charge layers in modulation doped superlattices. He emphasized that it can be used in situations where direct absorption spectroscopy is impossible, for example, in the observation of the higher minigap associated with devices fabricated on vicinal (100) planes.

Another approach to subband spectroscopy was presented in an invited talk by B. D. McCombe* and T. Cole (N.R.L.). McCombe described their absorption spectroscopy experiments on various Si devices through the use of a Michelson interferometer and a differential MOSFET gate modulation technique. Previously, measurement of subband energy separations were made by sweeping gate voltage and measuring the change of absorption at fixed frequency of far infrared laser radiation. This approach is relatively easy from an experimental point of view; however, it has a number of disadvantages, among which are the facts that the transitions can only be observed at a few discrete laser frequencies and true lineshapes cannot be determined since the electron density is varied during the gate voltage sweeps. These problems, and others, are overcome by the frequency domain spectroscopy described by McCombe, at the price of rather extensive efforts to optimize signal to noise. McCombe described the importance of many-body effects in understanding the qualitative and quantitative features of the subband spectra on the (100) Si surface, as well as recent work on the spectroscopy of (111) Si inversion layers with both twofold and sixfold degeneracy (see above discussion of the talk by D. C. Tsui). Dramatic differences in the spectra were observed in the two cases, and McCombe speculated about the possibility of the charge density wave mechanism as a possible explanation for some of the observed features. However, the situation is very complex, and a definitive result awaits more extensive theoretical calculations.

One session of the conference was given over to the presentation of both experimental and theoretical talks about anomalies that occur in semiconductor space charge layers at high magnetic field. Magnetoconductance and cyclotron resonance have shown unanticipated behavior at low electron density (the "localization" regime). For example, R. J. Wagner* (N.R.L.) and D. C. Tsui, and B. A. Wilson, S. J. Allen, Jr.*, and D. C. Tsui, (B.T.L.) presented cyclotron resonance data which showed that, for the case in which the lowest Landau level is half-filled, the resonance lineshape shifts and becomes very sharp. While a number of possible explanations can be suggested for this phenomenon, theoretical calculations have tended to emphasize that a charge density wave is most likely to form. In fact, the work of Wilson, Allen, and Tsui was analyzed on this basis. D. C. Tsui*, H. L. Störmer, A. C. Gossard, and W. Wiegmann (B.T.L.) presented magneto-transport results obtained on GaAs/GaAlAs superlattices which showed anomalous behavior somewhat akin to results obtained for Si inversion layers at low densities. Furthermore, Tsui showed cyclotron resonance data that also resembled the line narrowing phenomenon reported for the low-density inversion layers. Further work is required in this area to determine whether these effects are of the same origin as those in Si.

The final paper of the conference was a conference summary presented by F. Stern* (I.B.M.). Stern pointed out that, at this conference, a greater variety of materials was being studied and more techniques were being used to study them, e.g., Raman scattering, than at the two previous conferences. In the new material systems being studied, e.g., the III-V semiconductor heterostructures, high technology is becoming increasingly important. Progress in several areas was evident, for example the relationship between the different theories of valley splitting on (100) Si are much better understood and the underlying physics of the minigaps observed in various experiments on various planes of Si vicinal to (100) now seem to be reasonably well understood. Stern also pointed out a number of areas where questions are not yet resolved; among these were apparently

straightforward questions concerning the temperature dependence of the mobility, possibly more complex questions concerning the underlying cause of the observed valley degeneracy in Si (111) and (110) and its dependence on sample processing, and screening of "impurity" levels at the Si-SiO_2 interface. The area of localization and phase transitions in restricted dimensionality systems such as the semiconductor space charge layer system is currently undergoing some change with a new look at localization theories and additional experimentation. Stern also mentioned in this regard the new proposal, made at the conference by W. L. Bloss, L. J. Sham* (University of California, San Diego) and B. Vinter (Technical University, Munich), of a many-body (exchange and correlation)-induced phase transition at low densities which produces a valley splitting on (100) Si, thermally activated conductivity, and non-thermally activated Hall coefficient in agreement with experiments. The low-density (localization) regime clearly requires increased attention, both experimentally and theoretically.

In summary, the conference gave a fairly balanced view of the state-of-knowledge of electronic effects in 2D systems. While the level of controversy did not appear as high as in the two previous conferences (a clear indication that the field is maturing), the authors feel that this topical area holds a great deal of promise for the study of basic electronic properties, particularly the role of electron-electron interactions. A major new direction for the future appears to be in the area of compound semiconductor materials. For a more complete presentation, the reader is referred to the Conference Proceedings, which will be published in early 1980 in *Surface Science.*

FAR INFRARED SPECTROSCOPY AT OSAKA UNIVERSITY

R. J. Wagner and B. D. McCombe

A visit to Osaka University confirms what specialists in far infrared (FIR) spectroscopy of semiconductors have long suspected, namely, that this institution has certainly one of the largest and most varied efforts in the world. Three different groups, each in different colleges, are involved. With one exception, each of these groups has both FIR laser and FIR interferometer capabilities. Since each of these groups has different experimental interests and different solutions to instrumental problems, they will be discussed separately.

PHYSICS DEPARTMENT, COLLEGE OF GENERAL EDUCATION

Professor E. Otsuka, Physics Department, College of General Education, is currently involved primarily with optical and magneto-optical studies of electron-hole droplets in Ge. This work has involved microwave techniques, FIR (H_2O) discharge lasers and, more recently, optically-pumped (CO_2 laser from advanced kinetics) molecular gas lasers. However, this group is presently rather small with Dr. Ohyama and Mr. Nakata assisting Professor Otsuka. Previous work by Professor Otsuka was heavily involved with cyclotron resonance and related studies of InSb.

DEPARTMENT OF MATERIAL PHYSICS, *FACULTY OF ENGINEERING SCIENCE*

The largest FIR group at the university is that of Professor S. Narita, Department of Material Physics, Faculty of Engineering Sciences. The program of this group has focused on FIR magneto-optical properties of (a) small-band gap semiconductors, and (b) the D^- impurity center in both Ge and Si. This latter impurity center has been used by Professor Narita's group as a FIR detector with very good response speed. This group also developed an improved technique to interface the free electron (InSb) bolometer detector to external electronics. This technique utilizes a room-temperature discrete transistor and operational amplifier to replace the cold transformer normally used. This allows a substantial improvement in response time and a noise equivalent power equal to that previously reported.

The radiation sources in Professor Narita's laboratory are as follows:

1) both Lamallar and Michelson interferometers of British manufacture,
2) a FIR optical cavity pumped by a homemade CO_2 laser,
3) a FIR waveguide laser pumped by a homemade CO_2 laser and CO_2 amplifier, and
4) a 4-meter FIR waveguide laser pumped by a Lumonics TEA CO_2 laser.

Utilizing some of these sources, Professor Narita and his students have recently entered two new research areas. They are now studying cyclotron resonance of electron inversion layers in Si metal oxide semiconductor field effect transistors and, using the TEA CO_2 laser-pumped system, are planning to do nonlinear FIR spectroscopy.

DEPARTMENT OF PHYSICS, FACULTY OF SCIENCE

The last of the experimental groups is that of Professor K. Murase, Department of Physics, Faculty of Science. His program has tended to emphasize particular material systems; namely, $Pb_xSn_{1-x}Te$, as opposed to emphasizing FIR techniques generally. He has made use of a number of experimental techniques to study these

semiconductor systems. In the FIR, he utilizes a Digilab fast-scan interferometer with a dedicated mini-computer or a FIR waveguide laser pumped by a homemade CO_2 laser.

With Professor Otsuka and Mr. Nakata serving as hosts, the visit to the University of Osaka proved to be not only scientifically useful, but personally enjoyable as well.

Correspondence with any of these scientists should include departmental designation, Osaka University, 1-1, Machikaneyama-cho, Toyonaka, Osaka 560, Japan.

THE 16TH INTERNATIONAL COSMIC RAY CONFERENCE

Rein Silberberg

The International Union for Pure and Applied Physics, together with the Science Council of Japan and the Physical Society of Japan, sponsored the 16th International Cosmic Ray Conference, held 6-18 August 1979 at the New Miyako Hotel in Kyoto. The conference was attended by about 560 scientists; nearly half from Japan, about 100 from U.S., about 40 from U.S.S.R., about 20 from England, a similar number from Germany, and about 10 from India. Nearly 30 countries were represented. Japanese scientists have been active in cosmic-ray research for several decades. For example, the Seventh International Cosmic Ray Conference in 1961 was also held in Kyoto.

During registration for the conference, participants received a complete set of papers to be presented, bound into 11 volumes of about 4500 pages. The elaborate task of producing these books was accomplished by the Japanese organizing committee within two months after the deadline for submitting the papers. Due to the large number of papers presented, there were four simultaneous sessions, and the individual papers had to be restricted to about seven minutes. In light of these circumstances, it was of invaluable help to have the conference proceedings available in advance, and allotting the first two days of the conference for the study of these proceedings.

Cosmic rays prior to interactions in the earth's atmosphere are predominantly atomic nuclei, 90% hydrogen nuclei or protons, 10% helium nuclei, and 1% various heavier nuclei. There energies range from 10^6 to 10^{20} electron volts (eV).

Cosmic-ray physics is an interdisciplinary field of physics. It is related to elementary particle physics; many elementary particles were first observed in cosmic rays. While man-made accelerators now produce copious beams of elementary particles like p, n, e^+, e^-, π^+, π^-, K^+, K^-, K^0, μ^+, μ^-, and neutrinos, the highest energy interactions observed are still due to the cosmic rays that give rise to the extensive air showers.

Cosmic-ray physics is also related to high-energy nuclear physics. As the atomic nuclei in cosmic rays at energies of 1 GeV and above collide with the interstellar gas, or with the atomic nuclei of the earth's atmosphere, they break up; their elemental composition becomes thoroughly transformed. The systematic relations of high-energy nuclear breakup reactions are applied to understand the transformations of cosmic-ray nuclei.

Scientists who are working in plasma physics, and who are involved in the study of nuclear fusion reactors, also work on the acceleration and magnetic confinement of cosmic rays near their source regions.

Cosmic-ray studies are also related to work on nucleosynthesis–the "cooking" or creation of heavier elements like C, O, Ne, Mg, Si, Fe, etc., out of light elements like H and He in stellar interiors, under very-high pressures and temperatures. When these stars explode as supernovae, they spew out the heavy elements into the interstellar gas out of which new stars and planets arise. Since cosmic rays are enriched in heavy elements (relative to the surface composition of stars), they are likely to give information on processes of nucleosynthesis.

Studies of cosmic x-rays and γ-rays are related to the newly discovered and intriguing objects like pulsars, neutron stars, and black holes. These objects generate large fluxes of high energy photons. Active galactic nuclei and quasars are also powerful sources of x-rays and γ-rays–more than a billion times as powerful as the sun. The

"powerhouse" in such a source may be an ultra-massive black hole of 10^8 solar masses, or a gigantic star-like object, called a spinar.

Cosmic rays and high-energy solar flare particles can also have deleterious radiobiological effects, increasing the probability for contracting leukemia. The intense radiation belt around the earth (named after Van Allen) is derived from particles generated by cosmic-ray interactions in the earth's atmosphere that then become trapped by the earth's magnetic field.

Since cosmic-ray physics is related to many fields of physics and astronomy, as discussed above, the invited talks dealt largely with such related topics. Dr. T. Yamanouchi of the Fermi National Accelerator Laboratory, Batavia, Illinois, discussed the study of particle physics with accelerators and the most recent models of elementary particles. The basic constituents of matter are now considered to be the quarks held together by gluons inside protons and neutrons. There are now considered to be six classes of "flavors" of quarks. Another class of elementary particles is the leptons, probably also of six types: electrons, muons, tau-particles, and the corresponding neutrinos. Dr. Yamanouchi also discussed future colliding particle-beam experiments designed for the discovery of the massive intermediate bosons that are believed to be the sources of the weak type of nuclear interactions.

Dr. R. Giacconi of Harvard University presented a lecture on recent advances in x-ray astronomy. These results were obtained with the Einstein Observatory on a satellite, with a large improvement (about 1000 times) in detection threshold and angular resolution. Numerous observations of bright young stars, supernova remnants, active galactic nuclei, and quasars have been carried out during the current year, with measurements of energy output and time variability of sources.

Professor V. L. Ginzburg of Lebedev Institute, Moscow, discussed transition radiation that is produced when fast particles with a velocity nearly that of light traverse media with different indices of refraction. This radiation has been found promising for measuring the velocity and for identification of ultrarelativistic particles.

Professor D. N. Schramm of the University of Chicago presented a lecture on the origin of the solar system, relating it to the latest ideas of nucleosynthesis in supernovae. Recently discovered isotopic anomalies in meteorites imply that radioactive ^{26}Al, freshly produced by a supernova, must have contributed to the make-up of the solar system. In fact it is likely that a supernova shock wave precipitated the collapse of a presolar gas cloud that gave rise to the sun and planets.

Professor F. Reines of the University of California, Irvine, discussed atmospheric neutrinos that are generated as a result of collisions of cosmic-ray nuclei in the upper atmosphere and which are recorded by nuclear particle counters deep underground where neutrinos interact, yielding, a muon or electron and mesons. (Generally the muons have been used for detection due to their long range in matter.) He discussed experiments designed to explore whether protons are slightly unstable, with a half life of 10^{29} to 10^{34} years. (Recent elementary particle theories suggest this.) Such experiments would have to be carried out in deep mines, and methods have to be designed to eliminate the background generated by interactions of the atmospheric neutrinos.

Professor T. Obayashi of the University of Tokyo presented a lecture on auroral flares in the earth's magnetosphere. "Storms" in the terrestrial magnetosphere give rise to flaring phenomena, similar to the flares on the surface of the sun, though the energy release is about 10^{10} times less. Acceleration is particularly effective in the earth's magneto-tail that points away from the sun due to the solar wind pressure. The magnetic compression at the tail plasma sheet leads to explosive reconnection of field lines and associated betatron acceleration of particles.

The last invited lecture, on active galactic nuclei, was given by A. Cavaliere of Istituto di Fisica dell'Universita, Roma. The luminosity of these objects is 10^{43} to 10^{46} ergs/sec, much of it emitted as energetic x-rays and γ-rays. This power is emitted from extremely compact regions, as can be inferred from time variations on the scale of hours, days, or months. The emission region is likely to be very compact, having a dimension of

the order of 10^{15} cm, and it is extremely massive, about 10^{8} solar masses. It appears likely that these sources undergo gravitational contraction, and that gravitational energy is transformed into rotational energy, energy of electromagnetic fields, and high-energy particles.

The number of contributed papers on cosmic rays, following the above invited papers on related fields in physics, numbered several hundred. It is not possible to report on these in the current review. Instead, I shall briefly discuss recent progress in various fields of cosmic-ray physics, based on the highlights of the Kyoto conference, and a limited sample of the papers.

The sessions of contributed papers started out with a presentation of data of rapidly varying celestial x-ray sources (on a time scale of about a second) by the MIT group. These sources are considered to be accreting neutron stars or black holes. Professor Oda of Tokyo University discussed preliminary data from the newly-launched x-ray astronomy satellite Hakucho. This satellite is designed to make a panoramic survey of the sky for the x-ray burst sources, and to monitor transient x-ray sources, as well as to study steady and variable x-ray sources. They found that, for about three seconds on May 31, 1979, the source Cen X-4 reached an intensity of 40 times that of the powerful x-ray source of the Crab pulsar and nebula.

The production mechanisms of gamma rays from the galaxy were explored by Hayakawa and Matsumoto of Nagoya University. It had been believed earlier that, above 100 MeV, most γ-rays originate from π^0 decay and, below 100 MeV, from bremsstrahlung of electrons, and that γ-rays from the inverse Compton process are negligible. It is now shown that the density of infrared and optical photons in the inner region of the galaxy is higher; hence, the intensity of γ-rays produced by the collisions of these photons with electrons is higher. Thus, the inverse Compton process is found to be almost as important as bremsstrahlung.

Gamma rays from the powerful nucleus of the Seyfert galaxy NGC 4151 were measured by R. S. White and co-workers at the University of California, Riverside. They found the flux near 1-3 MeV to be 10 times lower than had been reported earlier by some research groups. It thus appears that the γ-ray flux from this source is variable or that the earlier experiments were in error.

Very-high energy γ-rays ($E > 10^{12}$ eV) were observed by Stepanian et al., of Crimea from Cyg X-3, a neutron star in a binary system. Eichler and Vestrand of the University of Maryland concluded on the basis of these data that the efficiency for acceleration of particles to very-high energies must be remarkably high in this source.

An international collaboration between research centers in U.S., Italy, France, and U.S.S.R. studied gamma-ray bursts and their source locations. They consider it likely that one source is a supernova remnant in the Magellanic Clouds, well outside our galaxy. W. K. H. Schmidt of Max Planck Institut für Aeronomie, Lindau, on the other hand, concluded that the burst sources are galactic and relatively close to our position in the galaxy.

Many papers were presented on the elemental composition of cosmic rays, improving our previous knowledge of the subject. A new breakthrough was the observation of antiprotons in cosmic rays by R. L. Golden et al. of New Mexico State University. They observed about 30 antiprotons, and found that the ratio $\bar{p}/p$ is 5×10^{-4}. This is in close agreement with the expected value of 4×10^{-4}, calculated from the theory of cosmic-ray confinement in the galaxy and antiproton production probability in cosmic-ray proton collisions with the interstellar gas.

During the last few years, techniques have been developed for measuring the isotopic composition of cosmic rays heavier than helium. Considerable progress was reported in this field at the Kyoto Conference. One surprising result was the high abundance of ^{22}Ne relative to ^{20}Ne, about 0.6. This is six times higher than for normal matter in the solar system, and two or three times higher than that of normal matter subjected to spallation reactions in interstellar gas calculated according to the procedures of Silberberg and Tsao. These observations were made independently by Greiner et al. of the University of California, Berkeley, and

Garcia-Munoz et al. from the University of Chicago. This observation seems to require a special type of nucleosynthesis in cosmic-ray source regions.

Several groups (Universities of New Hampshire, Minnesota, California, Kiel, and Lund) have finally developed methods for isotopic studies of heavier nuclei, in the mass range argon to iron. Only about 30 or 40% of Ca in cosmic rays is ^{40}Ca (compared to 97% in normal matter); the remainder are heavier isotopes produced largely by spallation of iron in the interstellar gas. No obvious anomalies seem to exist in the isotopic composition of iron, unlike the results reported a few years earlier.

There has been recent progress in the study of cosmic-ray electrons, whose abundance is only 1% of the protons. A collaboration between several groups in Japan and U.S. has extended the measurement of the electron spectrum to 10^{12} eV. They find that the shape of the energy spectrum implies a confinement time of cosmic rays of about 10^7 years in the galaxy. (This estimate takes into account the modification of the electron spectrum by interactions with the interstellar magnetic field and with photons.) The value of 10^7 years is consistent with the estimate based on the abundance of the long-lived radio nuclide ^{10}Be in cosmic rays. A collaborative study of English and Polish scientists finds that the energy spectrum of electrons can be explained if one adopts the truncated exponential distribution of cosmic-ray path lengths proposed by Shapiro and Silberberg.

Over ten papers dealt with the acceleration of particles to cosmic-ray energies. The most plausible process is now considered to be acceleration by supernova shocks in the interstellar medium. This subject has suddenly become popular–at the 1977 International Cosmic Ray Conference, W. I. Axford et al., Max-Planck Institut für Aeronomie, Lindau, introduced this topic in a conference paper. Acceleration of particles by shocks in interplanetary space, measured by satellites, was reported by several groups.

A paper by Silberberg and Tsao provided updated equations for nuclear breakup cross sections and fragmentation products during cosmic-ray propagation in interstellar gas. Professor Freier of the University of Minnesota organized an evening session on cosmic-ray propagation in which Silberberg and Tsao were asked to provide computer outputs of the nuclear breakup cross sections (or probabilities) to about 25 scientists, via Professor Freier, who would copy and distribute these.

Over ten papers were presented on cosmogenic radionuclides in deep-sea sediments, and on ^{7}Be on ground. These studies were carried out by Raisbeck and Yiou of Laboratoire de Spectrometrie Nucleaire et de Spectrometrie de Masse, Orsay, and by several groups in Japan. Cosmogenic radionuclides like ^{10}Be and ^{26}Al are produced by cosmic-ray interactions in the atmosphere, while ^{53}Mn and ^{59}Ni by cosmic-ray collisions in interplanetary dust and meteorites that settle on earth. One could infer that the mean long-term flux of cosmic rays near earth has been constant over several million years, while, from the ^{7}Be variations, one could note correlations with the 11-year solar cycle and solar modulation of cosmic rays.

A collaboration of German and American research groups discovered that the anomalously abundant low-energy ($\sim$ 10 MeV/nucleon) oxygen component had practically disappeared in late 1978 as the maximum in solar modulation approached, after having been observed for nearly a decade.

Energetic particles from solar flares were studied by several groups. A University of Maryland-Max Planck Institut für Extraterrestrial Physik collaboration explored a group of solar flares with unusual composition: those rich in the isotope ^{3}He. These were usually rich in iron (enhanced 10 times), and sometimes deficient in carbon.

Biological hazards associated with cosmic-ray and solar flare exposures were investigated by Silberberg and Tsao. Highly ionizing particles like heavy ions and neutron-generated nuclear recoils have a particularly high effectiveness for radiation damage. A dose of neutron recoils as low as 0.5 rad doubles the probability for contracting leukemia. The authors estimate the radiation risks on space flights and very-high altitude airplane flights at times of solar flares. They also evaluate the risks due to long-time exposures to cosmic rays, and prescribed shielding requirements.

Cosmic-ray detectors have now reached the orbit of Saturn and beyond, out to 19 astronomical units (AU or earth-orbit radii). Professor Simpson of the University of Chicago, McDonald of NASA, and Webber of the University of New Hampshire reported on data from the far-out Pioneer 10 and 11 satellites. The out-flowing solar wind still modulates the cosmic rays at these distances. Increased solar modulation during 1978 has suppressed the cosmic-ray flux near 15 AU. The anomalous helium component in cosmic rays (anomalous because of its large abundance with respect to protons at energies below 50 MeV/nucleon) has a particularly high intensity far out in the solar system. At 15 MeV/nucleon, it is about 10 times higher at 16 AU than near earth. Due to solar modulation, the flux was reduced by a factor of three during 1978. Solar modulation is found to be correlated with shocks associated with solar flares that propagate outward in the solar system. Near 10 MeV, small humps were observed in the spectra of C, Mg, and Si. These are attributed to a process similar to that which yields the anomalous oxygen. The latter, however, is about 100 times more intense than Mg or Si.

Elementary particle physics at very-high energies was explored in more than 100 papers. Some observations are described below. Professor Yodh and co-workers of the University of Maryland reported evidence for relatively stable massive particles in air shower cores. The mass exceeds that of protons by at least a factor of five. The conclusion is based on the relative time of arrival of air shower particles, hence it is based on somewhat indirect evidence. A Japanese collaboration reported the observation of an interaction at energies of 10^{14} eV in a balloon-borne emulsion chamber. Some of the particles produced in its interaction were neutral, with a short decay half life, ($\sim 10^{-13}$ sec). A Japanese-Brazilian collaboration observed several unusual interactions that were called the "Centauro events." In these high-energy collisions, the customary electron-positron "cascade" was practically absent; instead, the particles produced were charged pions or baryons. These events imply that new features occur in very high-energy nuclear interactions.

About 100 papers were presented on extensive air showers. These showers, consisting of more than 10^5 electrons and positrons at ground level, are generated by the collisions of the highest energy cosmic rays (energy $> 10^{15}$ eV) with nuclei in the atmosphere. The basic questions about these particles are: Are there new features of nuclear interaction at ultrahigh energies? How rapidly does the nuclear interaction cross section (interaction probability) increase with energy? What is the composition of these particles–protons or heavy nuclei? Different research groups have not yet been able to provide mutually consistent answers to these questions. However, from the anisotropies of their arrival directions, scientists now agree that those observed below energies of 10^{17} eV are largely galactic in origin, and those at the highest energies $E > 10^{19}$ eV, are mostly extragalactic.

About 70 papers were presented on cosmic-ray muons. Dr. G. Yekutieli of Weizmann Institute of Science, Israel, proposed a correction for the calculation of the μ^+/μ^- ratio. At large zenith angles, i.e., for particles at grazing angles in the atmosphere, the competition between pion decay into μ and pion collision in air favors the former. While this was known earlier, the proposed correction is new.

About 30 papers were given on projects, experiments, and calculations related to DUMAND, the Deep Underwater Muon and Neutrino Detector. Drs. A. Roberts of Fermi National Accelerator Laboratory, Batavia, and G. Wilkins of Naval Ocean Systems Center, Hawaii, presented a paper on the present design of the detector. About 20,000 Cerenkov light detectors would be spaced hexagonally within a volume of ocean water of 1.1 km^3, at a depth of 5 km. The light detectors would be supplemented by acoustic modules that record a pressure pulse generated by the meson and electron cascade from the interaction of a neutrino. The expected flux of neutrinos from cosmic-ray interactions in the atmosphere and in the gas of the galactic disk was calculated independently by Berezinsky and Volynsky of the Institute of Nuclear Research, Moscow, and by Stecker (National Aeronautics and Space Administration, Space Flight Center, Goddard) Shapiro and Silberberg of Naval Research Laboratory, Washington. They estimated that the DUMAND array should record about 10^5 atmospheric neutrinos per year above energies of 10^{12} eV. D. Eichler of the University of Maryland estimates that the number of neutrinos detected from an explosive burst in a quasar could be about 1000. Silberberg and Shapiro calculate that the DUMAND array could detect about 1000 neutrinos per year from the active galactic nuclei of Seyfert galaxies about 60 million light years away. The energy output of the latter sources exceeds that of the sun by about 10^{11} of 10^{12}. Shapiro and Silberberg also presented a paper on neutrinos from supernova remnants within half a year of the associated stellar explosion. They estimate that, within this period, over 1000 neutrinos would be observed

from the supernova shells, when formed in our galaxy. Allkofer of Institut für Reine und Angewandte Kernphysik, Kiel, Germany, with colleagues from Tokyo and San Diego, showed that the DUMAND array permits unprecedented high-energy muon research. The number of muons at energies $E > 10^{12}$ eV that enter the array in one year exceeds 10^{11}. Similar conclusions were reached by Petrukhin of Physical Engineering Institute, Moscow.

The last two days of the conference were devoted to 18 rapporteur papers. Selected experts summarized, compared, and analyzed the papers of the various specialities of cosmic-ray physics.

RAPPORTEUR SESSION

ORIGIN, COMPOSITION	*Rapporteur*
Special Symposium on X-ray Astronomy	Kanbach
Diffuse X-rays, X-ray Sources	Kanbach
Diffuse Gamma-rays	Kanbach
Gamma-ray Sources	Kanbach
Gamma-ray Bursts	Kanbach
Nuclear Composition	Balasubrahmanyan and Raisbeck
Isotopes	Balasubrahmanyan
Electrons and Positrons	Balasubrahmanyan
Production and Acceleration	Lingenfelter
Propagation	Lingenfelter
Interaction with Particles, Fields, Cosmology	Lingenfelter and Raisbeck
Secular Variation and Cosmogenic Nuclides	Honda
MODULATION, GEOMAGNETIC EFFECTS	
Modulation Theory	Jokipii
Space-borne Experiments	Iucci
Solar Cycle Modulation	Iucci
27-day Recurrences and Forbush Decreases	Iucci
Irregular and Rapid Variations	Iucci
Diurnal and Related Variations	Elliot
Sidereal Variations	Elliot
Geomagnetic and Atmospheric Effects	Elliot
Response Function	Elliot
SOLAR PARTICLES	
Acceleration	Sakurai
Composition	Sakurai
Solar X-, Gamma-rays, Nuclear Interactions, Coronal Propagation	Wibberenz
Interplanetary Propagation	Wibberenz
Others	Wibberenz
Outer Heliosphere	Webber
HIGH ENERGY	
Accelerator Results	Cline
New Particles	Cline
Nuclear Interactions	Fujimoto
Cascade Studies	Fujimoto

Gamma-ray Family	Fujimoto
High Energy Interaction Theory	Cline

EXTENSIVE AIR SHOWERS

Primaries	Sreekantan and Suga
Structure: Large Size	Suga
Structure: Medium and Small Size	Sreekantan and Kristiansen
High Energy Interaction	Kristiansen
Optical and Radio Emission	Kristiansen
Cascade Studies	Suga

MUONS, NEUTRINOS

Muon Intensities	Allkofer
Spectra, Charge Ratio: Experiment	Allkofer
Spectra, Charge Ratio: Theory	Allkofer
Muon Bundles	Allkofer
Muon Interactions	Allkofer
Neutrinos and Neutrino Interactions	Chudakov
Underwater Projects	Chudakov

ADDRESSES OF RAPPORTEURS

– Allkofer, O. C.
Institut für Reine und Angewandte Kernphysik
Olshausenstr. 40-60
D-2300 Kiel
West Germany

– Balasubrahmanyan, V. K.
NASA/Goddard Space Flight Center
Greenbelt, MD 20771
U.S.A.

– Chudakov, A. E.
Institute of Nuclear Research
Profsouznaya 7A
Moscow 117312
U.S.S.R.

– Cline, David B.
Dept. of Physics
University of Wisconsin
Madison, WI 53706
U.S.A.

– Elliot, H.
Physics Dept.
Imperial College
Prince Consort Road
London
United Kingdom

– Fujimoto, Yoichi	Science and Engineering Research Laboratory Waseda University 17 Kikui-cho Shinjuku-ku, Tokyo 162 Japan
– Honda, Masatake	The Institute for Solid State Physics University of Tokyo 7-22-1, Roppongi Minato-ku, Tokyo 106 Japan
– Iucci, N.	Istituto di Fisica dell'Universita Piazzale Delle Scienze, 5 00185 Roma Italy
– Jokipii, J. R.	Dept. of Planetary Sciences University of Arizona Tucson, AZ 85721 U.S.A.
– Kanbach, G.	Max Planck Institut für Extraterrestrial Physik D-8046 Garching bei München West Germany
– Kristiansen, G. B.	Nuclear Research Institute Moscow State University Moscow 117234 U.S.S.R.
– Lingenfelter, R.	Dept. of Physics C-011 University of California, San Diego La Jolla, CA 92093 U.S.A.
– Raisbeck, G. M.	Laboratoire de Spectrometrie Nucleaire et de Spectrometrie de Masse Faculté des Sciences Batiment 108, B.P. 1 91406 Orsay France
– Sakurai, Kunitomo	Institute of Physics Kanagawa University 3-27-1, Rokkakubashi Yokohama, Kanagawa 240 Japan

– Sreekantan, B. V.

Tata Inst. of Fundamental Research
Homi Bhabha Road
Bombay 400005
India

– Suga, Koichi

Dept. of Physics
Tokyo Inst. of Technology
2-12-1, Ookayama
Meguro-ku, Tokyo 152
Japan

– Webber, W. R.

Dept. of Physics
University of New Hampshire
Durham, NH 03824
U.S.A.

– Wibberenz, G. H.

Institut für Reine and Angewandte Kernphysik
Olshausenstr. 40-60
D-2300 Kiel
West Germany

COSMIC RAY RESEARCH IN JAPAN

Rein Silberberg

The standard of cosmic-ray physics has been excellent in Japan for several decades. The book, "Cosmic Ray Physics," published in 1969 by S. Hayakawa still is among the best on the subject. Japan has been the site of two international cosmic ray conferences, in 1961, and now in 1979. The latter is described in the previous article.

X-ray astronomy is one of the youngest and most rapidly developing fields in astronomy. Scientists at the Universities of Tokyo (Oda et al.), Nagoya (Hayakawa et al.), Osaka, and Rikkyo launched an x-ray satellite named "Hakusho" in February 1979. The satellite is spin-stabilized, and has detectors like proportional counters and scintillation counters. The objectives and early results of this study are outlined in the accompanying article on the International Cosmic Ray Conference in Kyoto.

About two years earlier, scientists from Tokyo and Osaka had studied the x-rays from supernova remnants like the Crab Nebula and Cygnus Loop, using rockets launched from the Kagoshima Space Center and high-altitude balloons. Further advances in x-ray and γ-ray astronomy in Japan are likely in the near future. Yoshimori et al. at Rikkyo have developed a spectrometer for the discovery of gamma-ray line emissions from neutron stars of pulsars. Suzuki et al., also at Rikkyo, have developed a gamma-ray telescope for the energy interval 10-30 MeV; this energy interval has been nearly unexplored to date.

Theoretical studies of the production mechanisms of γ-rays in the galactic disk are being pursued by Hayakawa and Matsumoto at Nagoya—their work is discussed in greater detail in my article on the Kyoto Conference.

In about 1960 Japanese scientists achieved good results of elemental resolution of cosmic rays using photographic emulsions. Subsequently, as various counter techniques (e.g., solid state detectors) replaced emulsions, the field of elemental and isotopic abundance measurements was nearly abandoned in Japan, while actively pursued in the U.S. and Europe. Most of the cosmic-ray research effort in the U.S. now is in the field of elemental and isotopic composition and its theoretical interpretation. Theoretical studies in this field are now carried on mainly in the U.S. and Europe. But, to many generalizations there are exceptions, and likewise here: Professor S. Hayakawa presented at Kyoto an excellent theoretical paper on blast waves generated by supernova explosions, and their effects on the propagation of cosmic rays in the interstellar medium and out of the galactic disk into the galactic halo. A collaborative group between five Japanese universities is developing a counter telescope for identifying elements in cosmic rays up to energies of 200 GeV/nucleon, and for the study of the mean isotopic composition near a geomagnetic cutoff rigidity of 10 GV (rigidity = momentum/charge).

A Japanese and American collaboration has succeeded in measuring the energy spectrum of cosmic-ray electrons to energies of 1000 GeV, using an emulsion chamber. These results are further described in my report on the Kyoto conference. A theoretical study of the energy spectrum of electrons and their propagation from sources to earth has been carried out by Professor J. Nishimura et al. at Tokyo.

The study of cosmogenic radio-nuclides is being actively pursued in Japan. Out of 30 papers on this subject, half were by scientists in Japan. Nuclides like ^{10}Be, ^{14}C, and ^{26}Al are produced by cosmic-ray interactions in the atmosphere and ^{53}Mn and ^{59}Ni by cosmic-ray interaction in the interplanetary dust and meteorite bodies. The aim is to explore time variations in cosmic-ray intensity by measuring their deposition rate in ocean bottom

sediments or in Antarctic ice fields. The rapporteur paper on this subject was given by Professor M. Honda from the University of Tokyo.

The theory of cosmic-ray intensity modulation by the out-flowing solar plasma is being pursued by K. Nagashima and I. Morishita at Nagoya University. In particular, they consider a 22-year, rather than 11-year, solar activity cycle and point out that during that portion of the cycle when the polar magnetic field of the sun is nearly parallel to the galactic field, the fields can connect and permit the entry of low-energy particles, such as those that give rise to the anomalous helium and oxygen components. Professor Nagashima is involved in several other studies of cosmic-ray modulation. For example, he observed, from the deep underground cosmic-ray muon data, that the Forbush decreases of cosmic-ray intensity that follow solar flares slightly suppress cosmic rays at energies as high as 500 GeV.

Professor K. Sakurai at Kanagawa University is among the leading world experts on acceleration of particles in solar flares. He gave the rapporteur paper on this topic. In his contributed paper, he concludes that the acceleration of particles (including nuclei) takes place within a couple of minutes during the explosive phase of the solar flare. He considers that the acceleration process is similar to that proposed by Fermi for the acceleration of cosmic rays in moving magnetic fields.

Japanese scientists are prominent in the field of elementary particle interactions by cosmic rays. The neutral heavy, short-lived particles (half-life about 10^{-13} sec) were observed by some Japanese groups. The "Centauro events" discussed in my paper on the Kyoto conference were discovered by a Brazilian-Japanese collaboration at the Extensive Air Shower Station on Mt. Chacaltaya. Japanese scientists employing emulsion chambers have observed electron-positron cascades generated by cosmic rays of very-high energy (10^{16} eV) a few km above the detector.

The study of the highest energy cosmic rays—the extensive air showers—is being pursued vigorously in Japan. The three large air shower stations are at Akeno, on top of Mt. Norikura, and on Mt. Chacaltaya. The latter is a Bolivian-Japanese collaboration. In these studies, one explores the energy spectrum, nature, and angular distribution of the particles (10^5 to 19^9 in number) that reach the ground level, and which are produced in a series of interactions in the atmosphere, initiated by a single nucleon or nucleus.

Research on cosmic-ray muons in Japan is first-rate, due to the efforts of numerous excellent scientists like S. Miyake and T. Kitamura, and to the new magnetic spectrogaph, Mutron, designed for these studies. Mutron consists of two iron magnets 8 m thick for bending the directions of the muons according to their charges and momenta. It includes trays of multiwire proportional counters and wire spark chambers for determining the location of article tracks. A calorimeter for inducing muon interactions is between the magnets.

Japanese scientists have been contributing to the DUMAND (Deep Underwater Muon and Neutrino Detector Program), both at the Hawaii and San Diego workshops, and recently at the Kyoto conference. At the latter, a design for high-pressure phototubes was presented, and also a study of the expected event rate of atmospheric neutrinos as a function of energy.

In conclusion, cosmic-ray research in Japan is equal to the best in the world in the sub-fields of cosmic-ray muon studies, extensive air showers, high-energy particle interactions, solar modulation, and solar particle acceleration. With the advent of the Hakucho satellite, x-ray research promises to be among the best. The work on the counter telescope for studies of elemental and isotopic composition makes me believe that, at the time of the next cosmic ray conference (in 1981), Japanese scientists will make valuable contributions, also, in this field. If I were asked for suggestions, I would propose work on track-recording plastics; new, more sensitive, ones are being developed, and there is enough opportunity for further progress in this field, including flights on the space shuttle.

APPENDIX

Active Cosmic-Ray Researchers

- Professor Sachio Hayakawa (Dean)
  Faculty of Science
  Nagoya University
  Furo-cho
  Chikusa-ku, Nagoya 464

- Professor Masataka Honda
  The Institute for Solid State Physics
  University of Tokyo
  22-1, Roppongi, 7-chome
  Minato-ku, Tokyo 106

- Professor Takashi Kitamura
  Cosmic Ray Laboratory
  University of Tokyo
  2-1, Midori-cho, 3-chome
  Tanashi, Tokyo 188

- Professor Masatoshi Koshiba
  Department of Physics
  Faculty of Science
  University of Tokyo
  7-3-1, Hongo
  Bunkyo-ku, Tokyo 113

- Professor Toshio Matsumoto
  Faculty of Science
  Nagoya University
  Furo-cho
  Chikusa-ku, Nagoya 464

- Professor Saburo Miyake (President)
  Cosmic Ray Laboratory
  University of Tokyo
  2-1, Midori-cho, 3-chome
  Tanashi, Tokyo 188

- Professor Isaburo Morishita
  Department of Physics
  Faculty of Science
  Nagoya University
  Furo-cho
  Chikusa-ku, Nagoya 464

- Professor Kazuo Nagashima
  Cosmic Ray Research Laboratory
  Nagoya University
  Furo-cho
  Chikusa-ku, Nagoya 464

- Professor Jun Nishimura
  Cosmic Ray Laboratory
  University of Tokyo
  2-1, Midori-cho, 3-chome
  Tanashi, Tokyo 188

- Professor Minoru Oda
  Institute of Space and Aeronautical Science
  University of Tokyo
  6-1, Komaba, 4-chome
  Meguro-ku, Tokyo 153

- Professor Kunitomo Sakurai
  Department of Physics
  Faculty of Science
  Kanagawa University
  3-27-1, Rokkaku-Bashi
  Kanagawa-ku, Yokohama 235

- Mr. Eiiki Suzuki
  Rikkyo University
  3-chome, Nishi-Ikebukuro
  Toshima-ku, Tokyo 171

- Professor Masato Yoshimori
  Faculty of Science
  Rikkyo University
  3-chome, Nishi-Ikebukuro
  Toshima-ku, Tokyo 171

RADIOBIOLOGY RESEARCH IN JAPAN

J. F. Weiss and G. N. Catravas

A recent trip, to attend the 6th International Congress of Radiation Research in Japan, gave us the opportunity to observe the status of radiobiology research in that country. The congress itself was described by us in a previous article which appeared in Vol. 4, No. 3, of this *Bulletin*. This short report, of course, will be a highly personal view based on our observations during the congress, during satellite symposia held in conjunction with the congress, and during trips to several laboratories engaged in radiation research. Our emphasis is on biological research, notwithstanding the superior work done in Japan in radiochemistry and physics, as well as radiation research applied to industry and agriculture.

For visitors from abroad, the course of radiobiology research in Japan seems to be most strongly influenced by one event: the atomic bombings at Hiroshima and Nagasaki. According to Dr. Fumeo Yamasaki of the Japan Radioisotope Association (Tokyo) in his address to the congress, a number of historical events have influenced the development and progress of radiation research in Japan. Apparently, radiobiological studies were first carried out in 1937 when a cyclotron was put into operation at the Institute of Physical and Chemical Research. This institute, at Wako, Saitama, continues as a major center of studies in both the physical and biological aspects of radiation effects. After the bombings of Hiroshima and Nagaski in 1945, the U.S. National Research Council organized a committee to survey the effects of the atomic bombings on survivors. This was the beginning of the Radiation Effects Research Foundation (RERF) in Hiroshima and Nagaski, which continues to provide most of our scientific knowledge on radiation effects in humans. The Bikini Islands atomic accident in 1954 further stimulated cooperative research on radiation effects. At about this time, studies that related to the peaceful use of radiation began in earnest in Japan—work important in the development of nuclear energy, radiotherapy, agricultural breeding, and the chemical industry. The Japan Atomic Energy Research Institute was founded in 1955, and its various laboratories have been important research centers involved in radiobiology research. The Japan Radiation Research Society was founded in 1958, and other societies related to the more specific aspects of radiation research have blossomed.

In 1957, the National Institute of Radiological Sciences (NIRS) was founded in Chiba. Today, the largest amount of radiobiological research is centered at this institute. It is difficult to single out the great centers of radiobiology research, since many individual scientists in universities and research centers contribute to the advancement of this science. Other than the institutes already named that receive most of their support from the government, their are other institutes that do noteworthy research, such as the Radiation Center of Osaka Prefecture, the Aichi Cancer Center in Nagoya, and the National Cancer Center Research Institute in Tokyo. Some universities have institutes or departments set up specifically to teach and perform radiobiology research, notably:

The Radiation Biology Center of Kyoto University;
The Department of Radiation Biology at Hiroshima University;
The Department of Radiation Biology of the Faculty of Medicine at Hokkaido University in Sapporo;
The Department of Radiation Biology of the Kyoto College of Pharmacy;
The Division of Radiation Biology, Faculty of Pharmaceutical Sciences, Kanazawa University;
The Department of Radiation Biophysics, School of Medicine, Kobe;
The Department of Radiation Biophysics, Atomic Disease Institute, Nagasaki University School of Medicine;
The Department of Radiation Biophysics, Faculty of Medicine, University of Tokyo; and
Radiation Microbiology, Department of Agricultural Chemistry, University of Tokyo.

Other university research in radiobiology is scattered within many departments and in many universities throughout the country: at Tokyo University and at smaller universities in the Tokyo area (Rikkyo, Tokyo Institute of Technology, Tokyo Metropolitan) and at Osaka, Nagoya, Tohoku, Kanazawa, and Kyushu universities. Radiobiological studies in the universities throughout Japan have centered mainly on effects of different sources, radiation chemistry of biological molecules and membranes, effects on cell proliferation, molecular damage and repair, chromosomal aberrations, mutagenesis and genetic effects, radiation carcinogenesis and other late effects, research related to radiotherapy, including sensitization, protection, and hyperthermia, medical risks of radiation exposure, and immunology. This great activity has led to the publication of the *Journal of Radiation Research*, one of the major international journals of radiation research (which publishes mainly in English) and other Japanese journals such as *Radiological Science* (published by the NIRS), *Radiation Biology Research Communications, Nippon Acta Radiologica, Journal of Nuclear Medicine, Japan,* and other cancer-related journals, as well as many reports from RERF.

The following reports on our visits to three cities, Hiroshima, Kyoto, and Chiba, which are centers of radiobiology research.

HIROSHIMA

Our host and guide during our visit to Hiroshima was Dr. Shigetoshi Antoku of Hiroshima University. Our first stop, soon after arriving in the city, was the Hiroshima Peace Park, the focal point of any visit to Hiroshima, especially for those interested in radiobiology. The eloquence of the Peace Memorial Museum, with its clear presentation of the bare facts of the event, speaks not only to the intellect but also to the heart. The museum fulfills the desire of the citizens of Hiroshima to promote world peace by increasing the awareness of atomic bomb effects. The museum exhibits are divided into sections related to the biological and medical effects of the atomic bombings: thermal radiation, blast pressure, ionizing radiation, and rescue activities. Of the total deaths of 140,000 persons in the period of acute sickness (the period from the time of the explosion on August 4, 1945, until the end of the year), about 20% were from injuries due to the blast, approximately 60% from burns due to thermal rays and fire, and the remaining 20% due to radiation disturbances. Thermal radiation was so intense that heat burns of the exposed human skin were observed to a distance about 3.5 km from the hypocenter. Many examples of the heat intensity are displayed in the museum, e.g., the surface of granite stones within 1 km of the hypocenter melted in the heat. Direct and indirect effects of blast resulted in many deaths; even at 3 km from the hypocenter, the maximum blast pressure was 1.3 tons/m^2 and the maximum velocity was 30 km/sec. The main components of initial radiation emitted in the air within 1 minute of the explosion were gamma rays and neutrons. The lethal radiation dose (700 rad) extended to approximately 925 m from the hypocenter, and the LD_{50} dose of 400 rad (or dose estimated to kill half the population) extended to 1.025 km. The location that was exposed to the permissible dose for human beings set by the International Committee for Radiological Protection of 0.5 rad was determined to be a point approximately 2.3 km away from the hypocenter. Residual radiation was present in the area of the bombing, and huge doses of radiation were carried to other parts of the city by "black rain" which fell soon after the bombings. Many persons have died over the years from chronic illness caused by radiation, including leukemia and malignant tumors; some are still suffering in hospitals from radiation-related sickness. The long-range continuing study for late radiation effects became the task of the Radiation Effects Research Foundation (formerly the Atomic Bomb Casualty Commission), established in April 1975. It is a private, nonprofit Japanese foundation supported equally with respect to financing, administration, and research direction by the Government of Japan (through the Ministry of Health and Welfare) and the Government of the United States (through the National Academy of Sciences under contract with the Department of Energy).

The work of RERF and the results to date have been discussed previously in the *Scientific Bulletin* (Bond, Vol. 2, No. 4; Catravas and Weiss, Vol. 4, No. 3). Much of the current research data from the RERF were presented at a meeting of the International Association of Late Effects Groups (IALEG) at the Hiroshima Peace Memorial Hall on May 21 and 22, 1979. As the name IALEG implies, this group is mainly interested in the delayed effects of radiation exposure. Dr. T. Sugahara, chairman of the Japan Late Effects Group and director of the Radiation Biology Center in Kyoto, played an important role in organizing this meeting, as did personnel of

RERF and the Hiroshima University Research Institute for Nuclear Medicine and Biology. Other than the experimental data presented, most of the data on human effects were from RERF and Hiroshima University. The studies relating ionizing radiation and carcinogenesis were concerned with types of tumors in the atomic bomb survivors, other late hematologic effects, and differences in atomic bomb survivors in Hiroshima and Nagasaki as related to the neutron component of the bombs. Another session described cytogenetic and genetic effects, including chromosomal aberrations in bone marrrow cells and in circulating lymphocytes. Other papers were concerned with duration of life and cause of death in the atomic bomb survivors and their children, as well as their medical and sociological problems.

The RERF facilities in Hiroshima are mainly a series of quonset huts on Mount Hiyajima, overlooking Hiroshima. On his arrival, the scientist visitor is usually given a comprehensive slide presentation describing the projects and results of the studies to date. The specific radiation-related programs are carried out in: (1) persons exposed as children or adults and their controls, (2) persons exposed *in utero* and their controls, and (3) children born to parents, one or both of whom were exposed, and their controls. Specific studies at RERF, not already noted, concern physical growth and development measurements during adolescence, atomic bomb and other radiation dose estimates (dosimetry), premature aging, fertility, immunological competence and cell function, radiation cataracts and other eye changes, cardiovascular disease, and biochemical genetics. The biochemical studies were of special interest to us. These are carried out in children of exposed parents to determine if mutations have occurred that result in changed serum protein and enzyme patterns. Dr. C. Satoh and her co-workers have an enormous job in studying 9,000 specimens (one-half are controls and the other half are children of exposed parents) for genetic variants of enzyme and proteins. Electrophoresis and other techniques are used. Automated chemistry laboratories are well equipped and are being updated.

Our last visit in Hiroshima was at the Institute of Nuclear Medicine and Biology at Hiroshima University. The Department of Radiation Biology (of which our host, Dr. Antoku, is a member) is a part of the Institute. This department, in cooperation with RERF, conducts epidemiological studies of medical and dental x-ray exposures of the A-bomb survivors and takes part in radioactivity surveys in the A-bomb fallout area. Their experimental studies focus on elucidation of the biological actions of radiation at the molecular and cellular levels, as well as dosimetry studies, i.e., absorbed dose evaluation of radiation in organs and qualitative analysis of cumulative types of radiation damage. Modification of radiation damage by chemicals and oxygen, metabolic inhibition of phospholipids by radiation, and DNA damage and repair mechanisms are also part of their research program. This department also manages the complete and extensive radiation facilities for the Research Institute of Nuclear Medicine and Biology and monitors the occupational exposure of the personnel of the institute. The exposure facilities available for their research include a therapeutic x-ray unit, a cobalt-60 gamma-ray unit, a 14-MeV neutron generator, and a linear accelerator.

KYOTO

Kyoto was host city for several symposia held in conjunction with the International Congress of Radiation Research. The International Symposium on the Prospects for Treatment of Radioresistant Cancers pointed out the work in this area not only in Kyoto (such as that by M. Abe in the Department of Radiology at Kyoto University) but also at other radiotherapy centers throughout Japan. Current studies were presented on the use of hypoxic cell sensitizers, heat treatment, high-LET radiation (fast neutrons and negative pions), californium-252 brachytherapy, and chemotherapy/radiotherapy combinations–all approaches that might be useful for the most resistant cancers.

The Radiation Biology Center of Kyoto University was the host for its 3rd International Symposium, the current topic being radiation sensitivity, repair, and protection. It was held on May 20-22 in a most-pleasing setting and with very economical arrangements at the Kansai Seminar House near the Shugakuin Imperial Villa and the Manshu-in Temple in the hills overlooking Kyoto. The theme of the symposium was DNA repair mechanisms, which is one of the main interests of both the radiation biology center and the chairman of the symposium, Dr. H. "Rocky" Takebe. Although most of the invited speakers were non-Japanese, the symposium provided an opportunity for many young Japanese investigators to present their work at poster sessions. Among

the Japanese speakers, M. Sekiguchi and K. Shimizu of Kyushu University described studies in which cells of *Escherichia coli* mutants (which are sensitive to UV irradiation) acquired considerable degrees of UV resistance after treatment of permeabilized cells with the DNA repair enzyme T4 endonuclease V. Dr. O. Nikaido from the radiation biology center and his colleagues from Shigu University described the establishment of a tissue culture cell line from fish fibroblasts, which they cultured for more than a year and at different temperatures with different growth characteristics. The temperature-dependent cells were used in radiation sensitivity experiments and their DNA characteristics were determined and compared to human fibroblasts. Compared to human fibroblasts, they were found to be more sensitive to ultraviolet irradiation but somewhat resistant to x-rays. That paper gives an idea of the model tissue culture systems that can be used for radiation research.

A variety of human cells have been grown at the radiation biology center and used in its experiments. Takebe and co-workers have an interest in rare human disorders called "chromosome breakage syndromes," which might contribute to an understanding of somatic cell mutations in relation to cancer. Individuals with these disorders have increased chromosomal breakage and proneness to cancer, which may show some similarities to gamma-irradiation breaks in chromosomes and rearrangements. The disorders include Bloom's syndrome, Faconi's anemia, and ataxia telangiectasia. In another disease, xeroderma pigmentosum, the cells from the affected individuals (who are also cancer-prone) show abnormally increased chromosomal instability after UV irradiation. Takebe and co-workers have studied 100 cases of xeroderma pigmentosum and the relationship between DNA repair and skin cancers. Approximately one-half were children under 10 years of age (that distribution being different than in other countries). The lower the DNA repair activity, the more frequent the skin lesions and the earlier the skin cancers develop in these patients. This genetic disease has a complex structure; there are seven genetic complementation groups and a variant type. The distribution of the groups is unique in Japan, in that there are more group A patients. This could be the reason why there are more xeroderma pigmentosum patients in Japan than in other countries (1/50,000). Takebe and M. Inoue of Kanazawa University presented information about the first group C patient of xeroderma pigmentosum identified in Japan. The cells from the patient were assayed for various DNA repair activities after UV irradiation. Takebe and his colleagues also confirmed the first cases of Bloom's syndrome in Japan–patients with a high frequency of spontaneous sister chromatid exchanges. These rare diseases have been shown to be unique models of radiation sensitivity; they may provide some ideas on cancer proneness after radiation exposure.

CHIBA

Our host at a visit to the National Institute of Radiological Sciences at Chiba was Dr. Mikio Shikita, head of the section of chemical pharmacology. It would take many pages to describe the extensive work at this institute, which is surely one of the largest institutes of its kind in the world. We will give only a general view of the research being done there and some specific examples. The mission of the NIRS is to contribute to applied and basic research activities in the fields of radiological sciences as follows:

(a) investigation of radiation hazards to human beings and of radiation protection.
(b) medical use of radiation, and
(c) analysis of radionuclides in the environment.

Training is also one of their major activities, with

(d) education and training in the fields of health physics, radiology, and nuclear medicine.

The activities are divided into two categories: one, basic studies are being carried out in every research division; in the other, three large projects are conducted with the cooperation of all scientists from relevant fields inside and outside the institute. The projects involve environmental and biomedical studies that have profound significance in developing radiation toxicology. One is the assessment of the risks of low-level radiation undertaken to cope with the increasing problems related to the development of nuclear power. The project is composed of three main groups:

(1) studies on the late somatic effects of low-level radiation, such as development of leukemia, in which special facilities are needed for breeding pathogen-free rodents;
(2) cytogenetic studies on radiation-induced chromosomal aberrations in primates and man, done mainly with peripheral blood lymphocytes, as well as germ cells of primates, and
(3) a multispecies approach to assessment of risks in man exposed to internal radiation emitters.

Another large project involves estimating dose from exposure to natural and man-made radiation. This includes studies of transfer to man of low-level radioactive wastes released into coastal waters, intake of radionuclides from food and water, exposure due to environmental contamination (which also involves a comprehensive mapping of natural radiation due to cosmic and terrestrial radiation in Japan), and the biological effects of tritium.

The third large institute project relates generally to medical use of the cyclotron and specifically to fast-neutron therapy of cancer, physical and biological studies of particle radiation therapy, short-lived radioisotope and radiopharmaceutical production and their clinical application, and positron-imaging studies. Our host for a tour of the cyclotron facilities was Dr. Yoshiko Kasida. The NIRS-Chiba isochronous cyclotron is a variable energy machine, accelerating protons up to 70 MeV or deuterons up to 43 MeV. The isochronous cyclotron differs from a classical cyclotron in that the magnetic field is made to increase radially to keep constant (isochronous) the period of revolution of particles. It was constructed and installed by Thomson-CSF, France. The cyclotron building has three independently-shielded caves: one for radioisotope production, one for radiotherapy and radiobiology, and one for general experiments. As in the other radiation facilities we have seen in Japan, the radiation safety, of the building housing the cyclotron facility, has been carefully considered. The vault and all irradiation rooms are interlocked by door switches and monitored by a television system. Monitoring of radiation levels is a prime concern.

The primary use of the NIRS cyclotron is the development of fast-neutron therapy of cancer. Some types of cancers (such as stomach cancer, which is prevalent in Japan) are resistnat to x-ray treatment, and neutrons are more effective for treating these radioresistant tumors. Since many human cancers arise and grow deep in the body, the energy of fast neutrons has to be sufficiently high to secure a good-depth dose. The cyclotron is the best machine to generate fast neutrons of high energy and high output for the purpose of treatment. A hospital is part of the NIRS facility and since 1975, when fast-neutron therapy was initiated, it has treated about 500 patients. Proton therapy is also being investigated, since this type of therapy could be used to irradiate a limited region of cancer with minimum destruction of normal tissue because of its characteristic dose distribution. Deep tumors can be treated only by direct irradiation under the surgical exposure of tumors at the NIRS facility, and the therapy room of the cyclotron facility can also be used as a surgery room. Increased studies of heavy particle therapy will be done in the future.

With regard to the production of radioisotopes, the special property of radioisotopes produced with a cyclotron is its short life, for example, fluorine-18 (half-life 112 min) for the diagnosis of bond cancer, carbon-11 (20.5 min) for lung function measurement, and nitrogen-13 (10.1 min) for blood flow measurements. Potassium-43, zinc-62, and iodine-123 are also being routinely produced. Outstanding progress is being made in the medical application of short-lived radioisotopes produced by the NIRS cyclotron. They contribute to the reduction of absorbed dose in the patient and the possible administration of a large quantity of radioisotopes, and consequently good images through the high-counting rate of a scintillation camera. Nuclear-medicine imaging is an area of high priority including development of instrumentation for positron imaging.

Besides the areas of project research, each research department is doing a variety of experiments related to its own expertise, which are physics, chemistry, biology, genetics, physiology and pathology, radiation pharmaceutical science, environmental health, radioecology and marine radioecology, clinical research, and so forth. For example, our hosts in the division of pharmaceutical science, Bun-ichi Tamaoki (the director) and Yoshita are doing research on the radiation hazard to endocrine systems. Specifically, they are studying the biosynthesis of steroid hormones in gonads, which are extremely sensitive to irradiation. This study includes purification of enzymes and determination of enzymatic pathways involved in steroid synthesis.

Other studies relate to radioprotection as well as the role of hormone-like substances that play a role in controlling proliferation and differentiation of blood cells (which are radiosensitive).

Our visit to NIRS and other radiobiology centers in Japan proved that there is much to be gained from international exchange visits. Because of the wide range of their basic knowledge, Japanese scientists can contribute much to radiobiology research programs in the United States. On the other hand, there is a need in Japan for younger scientists to work in the institutes devoted to radiobiology research, and visiting investigators from other countries could benefit from participation in Japanese research programs.

Appendix 1

Addresses of Radiobiology Research Activities in Japan

Aichi Cancer Center
81-1, Kanokoden, Tashiro-cho
Chikusa-ku
Nagoya, Aichi 464

Hiroshima University
Research Institute for Nuclear Medicine and Biology
1-2-3, Kasumi
Hiroshima 734

Hiroshima University
Department of Radiation Biology
Research Institute for Nuclear Medicine and Biology
1-2-3, Kasumi
Hiroshima 734

Hokkaido University
Department of Radiation Biology
Faculty of Medicine
Nishi-7-chome, Kita-15-jo
Kita-ku
Sapporo, Hokkaido 060

Institute of Physical and Chemical Research
2-1, Hirosawa
Wako, Saitama 351

The Japan Atomic Energy Research Institute
1-1-13, Shimbashi
Minato-ku, Tokyo 105

Japan Radiation Research Society
4-9-1, Anakawa
Chiba 280

Kanazawa University
Division of Radiation Biology
Faculty of Pharmaceutical Sciences
13-1, Takara-cho
Kanazawa 920

Kobe University
Department of Radiation Biophysics
School of Medicine
7-12-1, Kusunoki-cho
Ikuta-ku
Kobe, Hyogo 656-24

Kyoto College of Pharmacy
Department of Radiation Biology
5, Nakauchi-cho
Yamashina-Goryo
Higashiyama-ku, Kyoto 607

Kyoto University
Radiation Biology Center
Yoshida-Konoe-cho
Sakyo-ku, Kyoto 606

Kyoto University
Department of Radiology
Yoshida-Konoe-cho
Sakyo-ku, Kyoto 606

Nagasaki University School of Medicine
Department of Radiation Biophysics
Atomic Disease Institute
12-4, Sakamoto-cho
Nagasaki 852

National Cancer Center Research Institute
5-1-1, Tsukiji
Chuo-ky, Tokyo 104

National Institute of Radiological Sciences
4-9-1, Anakawa
Chiba 280

Radiation Center of Osaka Prefecture
704, Shinya-cho
Sakai, Osaka 593

Shiga University
1-1-1, Baba
Hikone, Shiga 522

University of Tokyo
Department of Radiation Biophysics
Faculty of Medicine
7-3-1, Hongo
Bunkyo-ku, Tokyo 113

Universitv of Tokyo
Radiation Microbiology
Department of Agricultural Chemistry
Ohmiya-cho
Naka-gun, Ibaraki 319

CIRCUITS, SYSTEMS, AND SIGNAL PROCESSING IN JAPAN

Sydney R. Parker

IEEE International Symposium on Circuits and Systems was held at the Pacific Hotel in Tokyo, on July 17-19, 1979. This meeting presented an unique opportunity for many U.S. researchers to meet their Japanese colleagues on a personal level. On the basis of this meeting, one is able to compile a list of Japanese researchers in various areas of this subject. Such a list is presented in Table 1.

In addition to attending the meeting, I was also able to visit several institutions including the Japanese Defense Academy, Kyoto University, Kobe University, and the Tokyo Institute of Technology. I presented a seminar (a short course in one case) at each, and was given an opportunity to observe their research activities firsthand. In particular, I was interested in their work in the area of digital signal processing.

The Japanese have had a long standing interest in circuits and systems because many of their faculty and industrial researchers received their doctorates in the U.S. with dissertations in this area. This interest has continued over the years, and many graduate students in Japan are also pursuing this type of research. Research at the Japanese universities I visited appears to be largely theoretical. In fact, I was somewhat surprised at the lack of signal-processing equipment at both the Defense Academy and Kobe University. Kyoto University, on the other hand, has very well-equipped computer laboratories, with the Tokyo Institute of Technology second.

In general, it appears that most experimental and device implemenation in signal processing is being done in industry, but I was not able to confirm this firsthand. The university faculty members I visited were most cordial, quite open in discussing their work, and certainly up-to-date with the current literature. I was impressed with their diligence and ability to obtain results, often under crowded conditions with rudimentary equipment.

KYOTO UNIVERSITY

Research at Kyoto University in the area of information systems is quite impressive. Professor Toshiyuki Sakai has developed a continuous speech understanding system (LITHAN), which is able to recognize over 100 words spoken by different individuals. The application is for automatic ticket sales for the Japanese railway system where the purchaser would speak into a machine. Professor Sakai, together with Associate Professor Takeo Kanade, also has a picture-processing and image-understanding laboratory. Their work is primarily directed toward image understanding, that is, detecting and identifying characteristics in pictures such as facial features, scene analysis, moving picture analysis, etc. Professor Makoto Nagao also has a sophisticated computer laboratory concerned with pattern recognition and picture processing, language processing, and artificial intelligence and learning systems. One of their projects involves research on handling Japanese character strings by computer, and they have computerized a large Japanese dictionary which contains 70,000 Japanese lexical entries. They plan to develop a large English-Japanese dictionary, using information such as idiomatic expressions and usage patterns of words.

TOKYO INSTITUTE OF TECHNOLOGY

Tokyo Institute of Technology is a newer institution, also with a broad range of faculty interests. Professor Takeshi Yanagisawa is a leader in the area of electronic circuits and networks and served as general vice-chairman of the IEEE Symposium Committee. The Department of Electrical and Electronic Engineering at Tokyo Institute of Technology is organized in three sections: electrical and electronic engineering, physical electronics, and

computer science. There also is a graduate school at Nagatsuta under Professor Takehiko Matsuda, which carries on teaching and research in the area of information processing. Their program appears to be quite broad in scope, but I was unable to visit their facilities because of lack of time.

KOBE UNIVERSITY

Research at Kobe University is primarily of a theoretical nature. Professor Kataro Hirano is engaged in the development of two-dimensional signal-processing algorithms and has published extensively in the journals. Several U.S. visitors have spent time with him. I was impressed with the type of work they were able to produce with relatively limited facilities.

JAPANESE DEFENSE ACADEMY

The Japanese Defense Academy is primarily a teaching institution, although they have both undergraduate and graduate programs at the master's level. The faculty performs surprisingly good research in several areas with limited facilities. Professor Takashi Suzuki has been a contributor to adaptive observers for some time and continues to work productively in this area. Also, Professor Yoshizumi Yosuoka is actively engaged in research in the area of optical electronics and appears to be getting some fundamental results. It is hoped that this article will be useful in establishing contacts between researchers with similar interests.

Table 1

Circuits and Systems Researchers
(1979 International Symposium)

Graph Theory	T. Watanabe	Hiroshima University, Hiroshima
	T. Ae	Hiroshima University, Hiroshima
	A. Nakamura	Hiroshima University, Hiroshima
	T. Kashiwabara	Osaka University, Toyonaka
	T. Fujisawa	Osaka University, Toyonaka
	T. Ozawa	Kyoto University, Kyoto
	T. Nishizeki	Tohoku University, Sendai
	G. Kishi	Tokyo Institute of Technology, Yokohama
	I. Sasaki	Tokyo Institute of Technology, Yokohama
	S. Shinoda	Chuo University, Tokyo
	Y. Kajitani	Tokyo Institute of Technology, Tokyo
	K. Onaga	Hiroshima University, Hiroshima
	W. Mayeda	Hiroshima University, Hiroshima
	T. Ohtsuki	Nippon Electric Co., Kawasaki
	H. Mori	Nippon Electric Co., Kawasaki
Graph Theory and Applications	T. Nishizeki	Tohoku University, Sendai
	T. Asano	Tohoku University, Sendai
	T. Watanabe	Tohoku University, Sendai
	S. Ueno	Tokyo Institute of Technology, Tokyo
	Y. Kajitani	Tokyo Institute of Technology, Tokyo
	K. Nakashima	Kyoto University, Kyoto
	Y. Hattori	Kyoto University, Kyoto
	T. Matsumoto	Fukui University, Fukui
Graph Theory and Combinatrics	T. Hirata	Tohoku University, Sendai

	A. Maruoka	Tohoku University, Sendai
	M. Kimura	Tohoku University, Sendai
	N. Kubo	Osaka University, Suita
	I. Shirakawa	Osaka University, Suita
	H. Ozaki	Osaka University, Suita
	S. Tsukiyama	Osaka University, Suita
	H. Ariyoshi	Ehime University, Matsuyama
	I. Shirakawa	Osaka University, Suita
	T. Chiba	Sharp Company, Tenri
	I. Shirakawa	Osaka University, Suita
	S. Goto	Nippon Electric Central Research Laboratories, Kawasaki
	T. Kashiwabara	Osaka University, Toyonaka
	T. Fujisawa	Osaka University, Toyonaka
	M. Iguchi	Osaka University, Toyonaka
Computerized Layout	A. Kishimoto	Nippon Electric Co., Kawasaki
	H. Kawanishi	Nippon Electric Co., Kawasaki
	H. Yoshizawa	Nippon Electric Co., Kawasaki
	H. Ohno	Nippon Electric Co., Kawasaki
	Y. Fujinami	Nippon Electric Co., Kawasaki
	K. Kani	Nippon Electric Co., Kawasaki
	S. Goto	Nippon Electric Co., Kawasaki
	H. Yoshimura	Yokosuki Electrical Communication Laboratory, Yokosuka
	K. Tansho	Musashino Electrical Communication Laboratory, Musashino
	N. Ohwada	Musashino Electrical Communication Laboratory, Musashino
	T. Nishide	Nippon Electric Co., Kawasaki
	K. Sato	Mitsubishi Electric Co., Itami
	T. Nagai	Mitsubishi Electric Co., Itami
	T. Kawamoto	Tokyo Institute of Technology, Tokyo
	Y. Kajitani	Tokyo Institute of Technology, Tokyo
	K. Sahara	Sharp Company, Tenri
	K. Kobori	Sharp Company, Tenri
	I. Nishioka	Sharp Company, Tenri
Layout Problems	S. Goto	Nippon Electric Central Research Laboratories, Kawasaki
	S. Yamada	Musashino Electrical Communication Laboratory, Musashino
	T. Watanabe	Musashino Electrical Communication Laboratory, Musashino
CAD Applications and Programs	H. Haneda	Kobe University, Kobe
	T. Maruhashi	Kobe University, Kobe
	S. Kusumoto	Kobe University, Kobe
	Y. Murakami	Osaka University, Suita
	N. Nishimura	Osaka University, Suita

Computational Methods for Nonlinear Networks	H. Kawakami	Tokushima University, Tokushima
	K. Kobayashi	Tokushima University, Tokushima
	A. Ushida	Tokushima University, Tokushima
	A. Sakamoto	Tokushima University, Tokushima
Nonlinear Network Analysis	S. Ichiraku	City University of Yokohama, Yokohama
	T. Endo	National Defense Academy, Yokosuka
	T. Ohta	National Defense Academy, Yokosuka
	K. Horiuchi	Waseda University, Tokyo
	S. Kumagai	Osaka University, Suita
	H. Takahashi	Osaka University, Suita
	S. Oishi	Waseda University, Tokyo
Circuit Design and Optimization	N. Kojima	Tokai University, Hiratsuka
	T. Machida	Tokai University, Hiratsuka
	T. Shinozaki	Tokai University, Hiratsuka
Passive Network Synthesis	T. Nishi	Kyushu University, Fukuoka
	T. Hosono	Nihon University, Tokyo
	K. Imamura	Saga University, Saga
	Y. Oono	Kyushu University, Fukuoka
System Theory	H. Maeda	Osaka University, Suita
	S. Kodama	Osaka University, Suita
	N. Yanagihara	Chiba University, Chiba
	S. Kawase	Railway Technical Research Institute, Kokubunji
	T. Ejima	Tohoku University, Sendai
	M. Kimura	Tohoku University, Sendai
	Y. Monden	Osaka University, Toyonaka
	S. Arimoto	Osaka University, Toyonaka
	S. Kondo	Tokai University, Hiratsuka
	S. Fujita	Tokyo Institute of Technology, Tokyo
	K. Tsuji	Tokyo Institute of Technology, Tokyo
	T. Fukao	Tokyo Institute of Technology, Tokyo
Control Systems	K. Furuta	Tokyo Institute of Technology, Tokyo
	T. Nomura	Tokyo Institute of Technology, Tokyo
	H. Kajiwara	Tokyo Institute of Technology, Tokyo
FIR Digital Filters	N. Takahashi	Tokai University, Hiratsuka
	T. Takebe	Kanazawa University, Kanazawa
	Y. Kobayashi	Tokai University, Hiratsuka
	A. Shindo	Musashino Electrical Communication Laboratory, Musashino
	Y. Sasajima	Musashino Electrical Communication Laboratory, Musashino
	T. Takahashi	Musashino Electrical Communication Laboratory, Musashino

	T. Aoyama	Musashino Electrical Communication Laboratory, Musashino
	S. Ono	Musashino Electrical Communication Laboratory, Musashino
	K. Nishikawa	Kanazawa University, Kanazawa
	H. Ueda	Yokosuka Electrical Communication Laboratory, Yokosuka
	T. Aoyama	Yokosuka Electrical Communication Laboratory, Yokosuka
Digital Filter Implementations	T. Kida	Tokyo Institute of Technology, Yokohama
	N. Ohsumi	Tokyo Institute of Technology, Yokohama
	R. Ishii	Yokohama National University, Tokohama
	A. Shionoiri	Yokohama National University, Tokohama
	S. Nishimura	Kobe University, Kobe
	K. Hirano	Kobe University, Kobe
	R. N. Pal	Kobe University, Kobe
	M. Kameyama	Tohoku University, Sendai
	T. Higuchi	Tohoku University, Sendai
Digital Filters	T. Takebe	Kanazawa University, Kanazawa
	K. Nichikawa	Kanazawa University, Kanazawa
	M. Kawai	Kanazawa University, Kanazawa
	K. Ohmura	Musashino Electrical Communication Laboratory, Musashino
	H. Tosa	Musashino Electrical Communication Laboratory, Musashino
	Y. Sasajima	Musashino Electrical Communication Laboratory, Musashino
	T. Aoyama	Musashino Electrical Communication Laboratory, Musashino
	S. Ono	Musashino Electrical Communication Laboratory, Musashino
	M. Hibino	Nippon Electric Company, Kawasaki
	K. Nakayama	Nippon Electric Company, Kawasaki
	T. Mizukami	Nippon Electric Company, Kawasaki
Design and Applications of Multi-Dimensional Digital Filters	K. Hirano	Kobe University, Kobe
	M. Sakame	Kobe University, Kobe
	M. Z. Mulk	Kobe University, Kobe
Switched Capacitor Networks	M. Kakuishi	Fujitsu, Ltd., Kawasaki
	S. Kato	Fujitsu, Ltd., Kawasaki
	A. Ito	Fujitsu, Ltd., Kawasaki
	T. Suzuki	Hitachi Central Research Laboratories, Kokubunji
	K. Yamakido	Hitachi Central Research Laboratories, Kokubunji

Filter Design and Approximation	T. Kida	Tokyo Institute of Technology, Tokyo
	K. Kurogochi	Tokyo Institute of Technology, Tokyo
	T. Matsuura	Tokai University, Hiratsuka
	T. Shinozaki	Tokai University, Hiratsuka
	Y. Takasaki	Hitachi Central Research Latoratories, Kukubunji
Active Filters	N. Fujii	Tokyo Institute of Technology, Tokyo
	R. N. G. Dalpadado	Osaka University, Toyonaka
	K. Hiwada	Shinshu University, Nagano
	M. Kudo	Shinshu University, Nagano
	S. Noguchi	Niigata University, Niigata
	E. Havahara	Nagoya Institute of Technology, Nagoya
	F. Ueno	Kumamoto University, Kumamoto
	T. Inoue	Kumamoto University, Kumamoto
	T. Kugumiya	Kumamoto University, Kumamoto
Modern Electrochemical Filters: Body-Wave Filters	M. Onoe	University of Tokyo, Tokyo
	T. Nagata	Matsushita Electric Ind. Co., Osaka
	T. Uno	Yokosuka Electric Communication Laboratory, Yokosuka
Modern Electromechanical Filters: Surface-Wave Filters	K. Shibayama	Tohoku University, Sendai
	Y. Yamanouchi	Tohoku University, Sendai
	H. Sato	Tohoku University, Sendai
	S. Takahashi	Toshiba Company, Kawasaki
	S. Fujishima	Murata Manufacturing Company, Kyoto
Stability Theory	T. Kohda	Kyushu University, Fukuoka
	Y. Oono	Kyushu University, Fukuoka
	Y. Ohta	Fukui University, Fukui
	T. Koga	Kyushu University, Fukuoka
	M. Itoh	Kyushu University, Fukuoka
Multi-Decision Maker Optimization Problems	T. Yoshikawa	Kyoto University, Uji
	H. Kobayashi	Meiji University, Kawasaki
	K. Mizukami	Hiroshima University, Hiroshima
Modeling and Analysis of Large-Scale Networks	S. Moriya	Tokyo Gas Company, Tokyo
	S. Takeda	Mitsubishi Electric Company, Itami
	Y. Nishikawa	Kyoto University, Kyoto
Distributed Networks	N. Nagai	Hokkaido University, Sapporo
	E. Maekawa	Hokkaido University, Sapporo
	H. Kunieda	Tokyo Institute of Technology, Tokyo
	G. Sugawara	Tohoku Gakuin University, Tagajo

	T. Sekine	Gifu University, Kagamigahara
	M. Nakada	Gifu University, Kagamigahara
	S. Yokoyama	Gifu University, Kagamigahara
	Y. Nemoto	Tohoku University, Sendai
	R. Sato	Tohoku University, Sendai
	F. Kato	Fujitsu Laboratories, Ltd., Kawasaki
	M. Saito	University of Tokyo, Tokyo
	K. Ohue	Yokosuka Electrical Communication Laboratory, Yokosuka
	A. Yata	Kumamoto University, Kumamoto
	T. Fukunaga	Kumamoto University, Kumamoto
Distributed and Multi-Variable Networks	H. Fujimoto	Kinki University, Higashi-Osaka
	J. Ishii	Kinki University, Higashi-Osaka
	H. Ozaki	Osaka University, Suita
	S. Okabe	Osaka University, Suita
	Y. Nemoto	Tohoku University, Sendai
Communication	G. Kishi	Tokyo Institute of Technology, Tokyo
	K. Sakaniwa	Tokyo Institute of Technology, Tokyo
	H. Murakami	Yokosuka Electrical Communication Laboratory, Yokosuka
	Y. Fukui	Tottori University, Tottori
	S. Yoneda	University of Osaka Prefecture, Sakai
	M. Makino	Yokosuka Electrical Communication Laboratory, Yokosuka
	M. Taka	Yokosuka Electrical Communication Laboratory, Yokosuka
	T. Yasushi	Yokosuka Electrical Communication Laboratory, Yokosuka
	T. Tsuboi	Yokosuki Electrical Communication Laboratory, Yokosuka
	H. Sakaki	KDD, Tokyo
	S. Shintani	KDD, Tokyo
	M. Aikawa	Yokosuka Electrical Communication Laboratory, Yoksuka
	H. Ogawa	Yokosuka Electrical Communication Laboratory, Yokosuka
Applications of Circuit Theory to Fiber Optic Communications Systems	Y. Mochida	Fujitsu Laboratories, Ltd., Kawasaki
	T. Ogawa	Fujitsu Laboratories, Ltd., Kawasaki
	K. Yamaguchi	Fujitsu Laboratories, Ltd., Kawasaki
	A. Miyauchi	Fujitsu Laboratories, Ltd., Kawasaki
	M. Tanaka	Hitachi Central Laboratory, Kokubunji
	I. Ikushima	Hitachi Central Laboratory, Kokubunji
	K. Nagano	Hitachi Central Laboratory, Kokubunji
	M. Maeda	Hitachi Central Laboratory, Kokubunji

Optical Communication Systems	H. Takada	University of Tokyo, Tokyo
	M. Saito	University of Tokyo, Tokyo
	K. Nosu	Yokosuka Electrical Communication Laboratory, Yokosuka
	H. Ishio	Yokosuka Electrical Communication Laboratory, Yokosuka
Electronic Circuits	Y. Imai	Tokai University, Hiratsuka
	T. Shinozaki	Tokai University, Hiratsuka
	I. Kawakami	Oki Electric Company, Tokyo
	T. Komazaki	Oki Electric Company, Tokyo
Network Approach to Biological Systems	M. Saito	University of Tokyo, Tokyo
	K. Nakayama	Sophia University, Tokyo
	F. Kajiya	Kawasaki Medical School, Okayama
	N. Hoki	Kawasaki Medical School, Okayama
	M. Imamura	Kawasaki Medical School, Okayama
	H. Kusuoka	Osaka University, Osaka
	S. Kodama	Osaka University, Osaka
	S. Kikkawa	Tokyo Women's Medical College, Tokyo
	I. Nemoto	Tokyo Denki University Tokyo
	I. Fukumoto	University of Tokyo, Tokyo
Network Analysis	H. Kitazawa	Tokyo Institute of Technology, Tokyo
	M. Sagawa	Tokyo Institute of Technology, Tokyo
	T. Nitta	Kyoto University, Kyoto
	A. Kishima	Kyoto University, Kyoto

Addresses of Activities Cited in Table 1

Chiba University
1-33, Yayoi-cho
Chiba, Chiba 280

Chuo University
3-9, Kanda-Surugadai
Chiyoda-ku, Tokyo 101

City University of Yokohama
4646, Mutsuura-cho
Kanazawa-ku, Yokohama 236

Ehime University
10-13, Dogo-Himata
Matsuyama, Ehime 790

University of Electro-Communication
1-5-1, Chofugaoka
Chofu, Tokyo 182

Fujitsu, Ltd.
1015, Kamiodanaka
Nakahara-ku
Kawasaki, Kanagawa 211

Fujitsu Laboratories, Ltd.
1015, Kamiodanaka
Nakahara-ku
Kawasaki, Kanagawa 211

Fukui University
3-9-1, Bunkyo
Fukui, Fukui 910

Gifu University
3-1, Nakamonjen-cho
Kagamigahara, Gifu 504

Hiroshima University
1-1-89, Higashi-Senda-cho
Hiroshima, Hiroshima 730

Hitachi Central Research Laboratories
1-280, Higashi-Koigakubo
Kokubunji, Tokyo 185

Hokkaido University
Nishi-5-chome, Kita-Hachi-jo
Kita-ku
Sapporo, Hokkaido 060

Kanazawa University
1-1, Marunochi
Kanazawa, Ishikawa 920

Kawasaki Medical School
577, Matsushima
Kurashiki, Okayama 701-01

KDD
2-1-23, Nakameguro
Meguro-ku, Tokyo 153

Kinki University
3-4-1, Kowakae
Higashi-Osaka, Osaka 577

Kobe University
1-1, Rokkodai-cho
Nada-ku, Kobe, Hyogo 657

Kumamoto University
2-39, Kurokami
Kumamoto, Kumamoto 860

Kyoto University
Yoshida-Honcho, Sakyo-ku
Kyoto, Kyoto 606

Kyoto University
Gokano-sho
Uji, Kyoto 611

Kyushu University
3576, Ohaza-Hakozaki
Higashi-ku, Fukuoka
Fukuoka 812

Musashino Electrical Communication Laboratory
3-9-11, Midori-cho
Musashino, Tokyo 180

Matsushita Electric Ind. Company
1006, Ohaza-Momma
Momma, Osaka 571

Meiji University
1-1, Kanda-Surugadai
Chiyoda-ku, Tokyo 101

Mitsubishi Electric Company
80, Aza-Nakano, Minami-Shimizu
Amagasaki, Hyogo 661

Murata Manufacturing Company
16, Nishijin, Kaiden
Nagaokakyo, Kyoto 617

Nagoya Institute of Technology
Gokisho-Cho, Showa-ku
Nagoya, Aichi 466

National Defense Academy
1-10-20, Hashirimizu
Yokosuka, Kanagawa 239

Nihon University
2-6-16, Nishi-Kanda
Chiyoda-ku, Tokyo 101

Niigata University
8050, Igarashi-Ninomachi
Niigata, Niigata 950-21

Nippon Electric Central Research Laboratories
1353, Shimonuma-gun
Nakahara-ku
Kawasaki, Kanagawa 211

Nippon Electric Company
1753, Shimonuma-gun
Nakahara-ku
Kawasaki, Kanagawa 211

Oki Electrical Company
550-5, Higashi-Asakawa-cho
Hachiohji, Tokyo 193

University of Osaka Prefecture
4-804, Mozu-Ume-machi
Sakai, Osaka 591

Osaka University
Ohaza-Yamadakami
Suita, Osaka, 565

Osaka University
1-1, Machikaneyama-cho
Toyonaka, Osaka 560

Railway Technical Research Institute
2-8-38, Hikari-cho
Kokubunji, Tokyo 185

Saga University
1, Honjo-cho
Saga, Saga 840

Sharp Company
2613-1, Ichinomoto-machi
Tenri, Nara 632

Shinshu University
3-1-1, Asahi
Matsumoto, Nagano 390

Sophia University
7, Kioi-cho
Chiyoda-ku, Tokyo 102

Tohoku Gakuin University
1-3-1, Tsuchitoi
Sendai, Miyagi 980

Tohoku University
2-1-1, Katahira
Sendai, Miyagi 980

Tokai University
1117, Kitakaname
Hiratsuka, Kanagawa 259-12

Tokushima University
2-6, Niikura-cho
Tokushima, Tokushima 770

Toshiba Company
1, Toshiba-cho, Komukai
Saiwai-ku
Kawasaki, Kanagawa 210

Tokyo Denki University
2-2, Kanda-Nishiki-cho
Chiyoda-ku, Tokyo 101

Tokyo Gas Company
1-16-25, Shibaura
Minato-ku, Tokyo 105

Tokyo Institute of Technology
(Yokohama)
4259, Nagatsuda-cho
Midori-ku
Yokohama, Kanagawa 227

University of Tokyo
7-3-1, Hongo
Bunkyo-ku, Tokyo 113

Tokyo Women's Medical College
10, Ichigaya-Kawada-cho
Shinjuku-ku, Tokyo 162

Tottori University
1-1, Koyama-cho
Tottori, Tottori 680

Waseda University
1-647, Totsuka-cho
Shinjuku-ku, Tokyo 160

Yokosuka Electrical Communication
Laboratory
1-2356, Take
Yokosuka, Kanagawa 238-03

Yokohama National University
156, Tokiwadai
Hodogaya-ku
Yokohama, Kanagawa 240

COLLISIONS OF RYDBERG ATOMS WITH GROUND STATE PERTURBERS

Thomas W. Mossberg

(Editor's Note: A global review of the XI International Conference on the Physics of Electronic and Atomic Collisions (XI ICPEAC) was published in the July-September 1979 issue of this *Bulletin*. In the present article, Dr. Mossberg gives a detailed survey of one of the many symposia held at the conference. He also gives a report of his visit to several research laboratories at Kyoto University.)

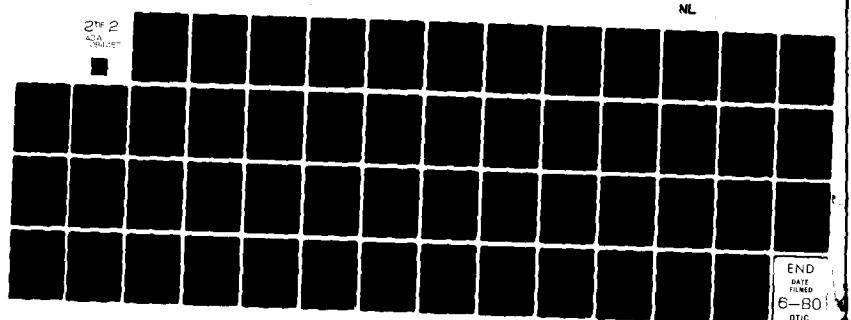
One of the symposia at XI ICPEAC was devoted to collisions of Rydberg atoms with ground state perturbers. A number of related contributed papers were also presented on this subject. A survey of the field was given by R. F. Stebbings (Rice University). J. F. Delpeck (University of Paris, Orsay) and T. F. Gallagher (SRI International, Menlo Park) discussed the experimental work on primarily-inelastic electron-Rydberg atom collisions and ground-state atom-Rydberg atom collisons, respectively. Rydberg atom-molecule collisions were discussed by R. D. Rundel (Rice University). M. Matsuzawa (University of Electro-Communications, Tokyo) discussed the theoretical aspects of collisions of neutral species with Rydberg atoms. Until recently, the most widely studied of the collision processes involving Rydberg atoms have been those involving changes of the state-of-the-Rydberg atom's electron. Numerous contributed papers presented new results on such processes. The group of M. Hugon, P. R. Fournier, F. Gounand, and J. Berlande of France presented results on the collisional depopulation of Rydberg F states in Rb. F. G. Kellert and coworkers (Rice University, Houston) reported on depopulation rates Xe(nf) atoms in collisions with ammonia. A Hitachi (Science and Engineering Research Laboratory, Waseda University, Tokyo) reported on the depopulation of highly excited He($n^{1,3}S$) states in collisions with noble gas atoms. Some of the other work presented related to the effect of backbody radiation on Rydberg atoms (E. J. Beiting et al., Rice University), reactions of highly excited H_2 molecules with H_2O and SF_6 (H. Hiraishi, M. Uematsu, T. Knodow, T. Fukuyama, and K. Kuchitsu of the Department of Chemistry, University of Tokyo). The work of the author and coworkers, which utilizes a laser coherent transient effect (the tri-level echo) to study collisional broadening of forbidden ground-Rydberg state transitions, opens up new aspects of the study of collisions involving Rydberg atoms. We reported measurements of the broadening of the 3S-nS and 3S-nD ($n = 4 - 40$) transitions of Na by the noble gases. The general interest in collisions involving Rydberg atoms relate, of course, to the fact that the outer electron of the Rydberg atom is far removed from the atomic core (e.g., for Na at $n = 40$, the average electron-core separation is roughly 1000 Å). This fact leads to interesting collisional effects. For example, contrary to what might be expected, collisional cross sections generally reach a peak at relatively low values of principal quantum number, n, and subsequently decline as n increases further. This is in spite of the fact that the geometric cross section of the Rydberg atom continues to increase with n as n^4.

Ancillary to the conference functions, the author had the opportunity to visit several research laboratories at Kyoto University. Professor M. Matsuoka and his research associate, H. Nakatsuka, described their work on laser coherent transient phenomena and superfluorescence. They recently (at the same time as, but independently of the author and coworkers) showed that a three-pulse (stimulated) photo echo can be generated in a gas when the third pulse counterpropagates with respect to the first two. This has not only provided a deeper understanding of echo phenomena, but also provides a useful experimental technique for studying relaxation processes on the picosecond time scale. The stimulated echo can provide a detailed characterization of elastic collision processes in gases and other types of relaxation processes in solids. Professor Matsuoka has access to the state-of-the-art laser equipment, and using Nd:YAG-laser-pumped dye laser amplifiers to produce high-power picosecond laser pulses (from a mode-locked cavity-dumped cw dye laser), he can be expected to perform some interesting work in the

AD-A084 457 OFFICE OF NAVAL RESEARCH SCIENTIFIC LIAISON GROUP AP--ETC F/G 8/1
ONR TOKYO SCIENTIFIC BULLETIN. VOLUME 4, NUMBER 4, OCTOBER-DECE--ETC(U)
DEC 79 R J MARCUS, E MOHRI

UNCLASSIFIED

NL



near future. Professor T. Hashi and his associate, Y. Fukuda, are also working on coherent transient effects. In particular, using N_2-laser-pumped dye lasers, they are studying the effects of collisions on population gratings induced in Na vapor. They have designed an interesting actively mode-locked "cw" dye laser. Instead of using passive mode-locking techniques or synchronous pumping with a mode-locked pump laser, they use an acoustoptic modular inside the dye laser cavity to provide direct active mode-locking. Professor T. Yabuzaki of the ionosphere research laboratory of Kyoto University demonstrated the apparatus with which he has performed studies of collisional transfer between orientation and alignment in atoms excited by a single mode cw laser. He and his associates find that collisions affecting the nonthermal distribution of atoms excited by the laser cannot be treated as isotropic. Interestingly, they have designed a cw dye laser which is made single-mode through the use of an intracavity Faraday rotator as the sole frequency selective element. In such a design the dye laser frequency is automatically stabilized to an atomic transition frequency. The mailing address for Kyoto University is: Yoshida-Honcho, Sakyo-ku, Kyoto, Kyoto 606.

SYMPOSIUM ON DESIGN OF INORGANIC AND ORGANIC MATERIALS OF TECHNOLOGICAL IMPORTANCE

Rudolph J. Marcus

An international meeting on "Design of Inorganic and Organic Materials of Technological Importance" at Kyoto, 31 October-1 November, 1979, focussed entirely on non-metallic conductors and semiconductors. Some of the research on these materials had begun in Japan; the 90%-Japanese audiences relished reminders of that, as well as relishing the opportunity to catch up on new materials and their new properties. In brief, the new materials are all π-bonded carbon compounds, and their properties have been changed by doping so that conductivities exceeding that of copper have been achieved.

G. B. Street of I.B.M., San Jose, gave a timetable of recent developments:

1953 $(SN)_x$ pellets found to be semiconductors
1973 $(SN)_x$ found to be metallic
1975 $(SN)_x$ found to be superconducting
1977 halogen derivatives of $(SN)_x$
1977 $(CH)_x$ doped to be metallic or semiconducting
1979 polypyrrole
1979 polyparaphenylene.

The intercalation of graphite was not on Street's timetable and is a relatively old subject of research. Even here, however, the use of new electron acceptors such as arsenic pentafluoride and antimony pentafluoride as intercalants has resulted in compounds which have a conductivity equal to (antimony pentafluoride) or higher (arsenic pentafluoride) than that of copper. This was announced by F. L. Vogel of the University of Pennsylvania, who is editor of a new journal, *Synthetic Metals,* to be published by Elsevier Sequoia in Lausanne, Switzerland.

Because of the high anisotropy of graphite–anisotropy factors of 4000 were quoted–Vogel used a radio-frequency method to measure resistivity. The sample was inserted in the gap of a ferrite coil, driven by an oscillator. and thus changed the Q of the coil. Resistivity vs. intercalation time curves clearly showed several plateaus. These were identified by Vogel as "stages," corresponding to different stoichiometries. For example, stage 2 arsenic pentafluoride (two carbon layers, one arsenic pentafluoride layer) showed a conductivity of 6.3×10^5 ohm^{-1} cm^{-1}, which corresponds to the conductivity of metallic silver. Stage 3 arsenic pentafluoride (three carbon layers, one arsenic pentafluoride layer) showed a conductivity of 5.8×10^5 ohm^{-1} cm^{-1}, equivalent to that of metallic copper, as did stage 6 antimony pentafluoride (six carbon layers, one antimony pentafluoride layer). Vogel cited the NMR work of Henry Riesing at N.R.L. as being helpful in checking stoichiometries.

The material spoken of most frequently at the conference was polyacetylene. A. G. MacDiarmid and A. J. Heeger, a chemist and a physicist respectively, O.N.R. contractors at the University of Pennsylvania, both gave masterful introductory papers in this material. Cis-polyacetylene is prepared with a Ziegler catalyst at −78°C; heating at 200°C changes the red cis-polyacetylene to blue trans-polyacetylene. The material exists as curly fibers, a mass of which is two-thirds air space. The strings can be aligned by stretching; the conductivity is then greater in the stretched direction. Conductivity of the undoped cis-polyacetylene is 10^{-9} ohm^{-1} cm^{-1}, of the trans-polyacetylene is 10^{-5} ohm^{-1} cm^{-1}. Doping, which can be done electrolytically in water solution, increases conductivities to within one-two orders of magnitude of copper. Both n- and p-type doping can be accomplished.

Alkali cation dopants give n-type materials; halide and other electronegative anions give p-type materials. Doping appears to proceed to about 0.4 dopant per carbon atom, in contrast to graphite where stage 1 has one dopant per six carbon atoms (one phenyl ring), stage 2 half that number, stage 3 one-third, etc. The p-type materials seem to be easier to handle than the n-type materials; n-type polyacetylene with sodium inclusions bursts into flame spontaneously. On the other hand, p-type polyacetylene loaded with arsenic pentafluoride will not pass consumer safety tests either.

The ultimate chemical fate of the dopants was discussed by a number of authors. Perhaps the most direct experimental evidence presented at this meeting has been collected by J. J. DeCorpo of N.R.L., who has determined warming curves of p-type polyacetylene doped with arsenic pentafluoride. Mass spectrometer analyses of the material released show that the arsenic trifluoride is released above room temperature, and thus that complete charge transfer has taken place between the arsenic pentafluoride dopant and the polyacetylene, forming AsF_6^-.

The other new materials listed by Street were discussed briefly. Polypyrrole, according to Street, can be prepared electrochemically from pyrrole in aqueous acetonitrile. In contrast to polyacetylene, it is not fibrous and can be made into continuous sheets. It has good stability and does not need doping, although its conductivity is three orders of magnitude below that of copper. It is not yet known whether doping will increase that conductivity. Its conductivity can be varied over five orders of magnitude below the maximum by copolymerization with N-methylpyrrole.

Polyparaphenylene was discussed by R. H. Baughman of Allied Chemical. It is midway between polyacetylene and graphite and can be n- or p-doped similarly to those materials. The temperature dependence of its conductivity is non-Arrhenius, and therefore non-metallic, presumably because of interparticle contact resistance. The highest conductivity obtained so far is even lower than that of polypyrrole, about four orders of magnitude below that of copper. However, polyparaphenylene is stable to 400°C in air and is moldable by powder-metallurgical techniques. Moldable at ordinary temperatures is polymetaphenylene, the most electronegative polymer, with a band gap of 6.5 eV (~250 nm). It comes in two forms, cis-trans and trans-trans, can be p-doped with arsenic pentafluoride up to 0.4 dopant per phenyl ring, one-sixth the dopant concentration possible with polyacetylene. Because polyphenylene and polypyrrole were only announced this year, a good deal more optimization of properties can be expected.

These new materials can be used to make rectifying junctions and photovoltaic junctions. Heeger described a Schottky diode, made by polymerizing polyacetylene *in situ* on a gallium arsenide base and then doping it with arsenic pentafluoride. The resulting diode has an efficiency of about unity at 3 v, and an efficiency of 10^{-2} at 2 v. He also described zinc sulfide and cadmium sulfide n-p heterojunctions with p-type polyacetylene.

MacDiarmid used a polyacetylene-coated platinum electrode in polysulfide solution as a solar cell. At one sun incident on the electrode, he obtained 0.3 v open circuit voltage, 40 $\mu A/cm^2$ current density, and an unoptimized absolute efficiency of 1%. Shirakawa (now at Tsukuba Science University) has measured a 4.5% efficiency with an n-p heterojunction, using n-type silicon and a 0.5-0.6 μm layer of p-type polyacetylene. When used as a solar cell, the open cell voltage was 0.53 v, and current density was 18.2 mA/cm^2.

Other uses foreseen by Ovshinsky of Energy Conversion Devices, Inc., for these materials include thermoelectricity, catalysis, and inert coatings. Shirakawa has used polyacetylene as a catalyst for hydrogen-deuterium exchange.

These materials appear to be a unique wedding of synthetic chemistry semiconductor physics. The ease of synthesis and fabrication; the controllability of band gap, conductivity, carrier charge, carrier concentration, and carrier mobility; and the structural rigidity all mark these new materials as real comers in the world of semiconductor devices.

The following papers were given at this meeting. Abstracts of these papers are available in this office and selected ones can be mailed to those who request them.

Name and Address	*Title*
– A. G. MacDiarmid Dept. of Chemistry University of Pennsylvania Philadelphia, PA 19104 U.S.A.	Organic metals and semiconductors: the chemistry of polyacetylene, $(CH)_x$, and its derivatives
– A. J. Heeger Dept. of Physics University of Pennsylvania Philadelphia, PA 19104 U.S.A.	Organic metals and semiconductors: the physics of polyacetylene, $(CH)_x$, and its derivatives
– S. R. Ovshinsky Energy Conversion Devices, Inc. 1675 West Maple Rd. Troy, Michigan 48084 U.S.A.	Chemical concepts and techniques for synthesizing inorganic amorphous materials
– F. L. Vogel Moore School of Electrical Engineering University of Pennsylvania Philadelphia, PA 19104 U.S.A.	High electrical conductivity of acceptor intercalation compounds of graphite
– H. Shirakawa Research Lab. of Resources Utilization Tokyo Institute of Technology Negatsuta-cho, Midori-ku Yokohama 227, Japan	Application of doped polyacetylene films to solar cells
– A. A. Ovchinnikov Karpov Institute of Physical Chemistry Ul. Obukha 10 107120, Moscow B-120 U.S.S.R.	The problem of the design of organic ferromagnetics
– J. J. DeCorpo U.S. Naval Research Lab. Code 6110 Washington, DC 20375 U.S.A.	Mass spectral studies of electroactive polymers
– K. Kaneto Dept. of Electrical Engineering Faculty of Engineering Osaka University Yamada, Suita Osaka 565, Japan	Electrical properties in crystalline $(SN)_x$ and $(SNBr_y)_x$

– G. B. Street
IBM Research Lab.
5600 Cottle Rd. K32/281
San Jose, CA 95193
U.S.A.

Conducting polymers

– R. H. Baughman
Corporate Research Center
Allied Chemical Corporation
Morristown, NJ 07960
U.S.A.

The physics and chemistry of new organic polymeric metals

– K. Okuda
Kureha Chemical Ind. Co.
R & D Division
16 Ochiai Nishikicho
Iwaki-shi, Fukushima 974
Japan

New carbon and graphite from pitch containing a liquid crystal

– E. Maruyama
Central Laboratory
Hitachi, Ltd.
1-280 Higashikoigakubo
Kokubunji-shi, Tokyo 185
Japan

Computer-controlled evaporation of amorphous chalcogenide multilayer

INAUGURAL MEETING OF THE FEDERATION OF ASIAN CHEMICAL SOCIETIES

Rudolph J. Marcus

A rare opportunity to meet chemists from eleven different countries occurred 13-16 August, 1979, at a meeting in Bangkok, Thailand. The meeting involved representatives of chemical societies from eleven countries in Asia and Australia, and was called to form a regional federation of these societies. The names and addresses of those who participated are listed in the Appendix; they form an invaluable resource for any chemist planning visits to those particular countries. Two large countries are missing from the list. The Chemical Society of Japan chose to be represented only by an observer, and I do not know whether the People's Republic of China was invited or not.

The resources of the area, in terms of chemists and of universities, are shown in Table I, which was made up at the conference. The concerns, needs, and specialities of chemists in the various countries were delineated in short 20-minute country reports. The particular strengths and interests of chemists in these countries are listed below as best as I could glean them from the country reports.

Table I

Chemistry Resources of Eleven Asian Countries

	Estimated number of Chemists	Universities	
		Total	Chem. Major
Australia	14,000	19	19
Hong Kong	1,000	2	2
India	59,000	117	30
Indonesia	1,000	12	12
Iraq	2,000	8	7
Korea	2,000	84	26
Malaysia	3,000	5	5
Phillipines	5,000	18	10
Singapore	1,000	2	2
Sri Lanka	7,000	7	7
Thailand	2,000	18	10

AUSTRALIA

Funding for research projects at universities is made through the Australian Research Grants Committee. This committee makes annual awards mainly in the sciences but also in the humanities; each application is refereed. Of the total grants of $12 million in 1979, $1.6 million went to projects in the chemical sciences. The awards cover special equipment, maintenance, research assistants, and research fellowships. It is assumed that the basic facilities, such as laboratories, non-specialized equipment, workshops, etc., are already available at the applicants' institution.

In addition to university research, the Commonwealth Scientific and Industrial Research Organization (CSIRO) has several divisions which are specifically concerned with research in chemistry. These are applied organic chemistry, chemical physics, chemical technology, and mineral chemistry. There are also significant chemical research components in the CSIRO divisions of materials science, plant industry, process technology, and protein chemistry.

Fields of special interest in Australia include spectroscopy of all types, i.e., UV-visible, IR, Raman, laser Raman, CD, NMR, ESR, and mass spectrometry, usually directed towards structure and mechanistic studies, but also towards improvement in instrumentation; mechanism and kinetics of reactions (organic and inorganic); synthetic organic chemistry; synthetic inorganic chemistry; structure and synthesis of natural products; coordination chemistry; organometallic chemistry; cluster compounds; bioinorganic compounds and the part played by metals in biological reactions; macromolecular chemistry of both natural biopolymers and synthetic high polymers; nitrogen fixation; surface chemistry; crystal chemistry and structure determination by x-ray and neutron diffraction; solid state chemistry; electrochemistry; thermodynamics; diffusion processes; photochemistry; photoluminescence; fluorine chemistry; reactions in molten salts, free radical chemistry; theoretical chemistry; *ab initio* molecular orbital calculations; intermolecular forces, both calculation and measurement; radiation and radiochemistry; analytical chemistry; and astrochemistry.

Chemical industry is firmly established in Australia, and a wide range of heavy and fine chemicals are manufactured. There is a major plastics and synthetic fiber industry, as well as the refining of ores and purification of metals associated with the mining industries. However, the research and development effort in the chemical industry is not as great as some would like. This is due to the tendency of the multinational companies to have their research and development laboratories in the northern hemisphere and to restrict the research effort in Australia to a minimum (a complaint echoed by many other countries). It is also due to the taxation policy of the Australian Government which, it is said, does not encourage the return of profits into the company to foster research and development.

HONG KONG

Basic research is pursued vigorously in the chemistry departments of two universities, producing annually over 50 papers published in international chemistry journals. These come mainly from young faculty members. Parenthetically, there is intense competition even for junior faculty positions, each opening generating 50 applications or more. There is some modern and expensive instrumentation at the two universities, such as an automated x-ray diffractometer, modern multi-nuclei Fourier transform NMR, ESR, and a high-resolution mass spectrometer. There exists a $1-million grant for interdisciplinary research on Chinese medicinal material. Long-term applied research is also conducted on environmental problems and on the production of food proteins from wastes.

There are only few large chemical plants in Hong Kong. These produce polystyrene, cement, chlorine, and caustic soda. This is the result of the limitation of land and raw material in Hong Kong. A fair number of chemists is employed in the other major industries of Hong Kong, but not much industrial research is being done there. A third institution besides the two universities, the Hong Kong Polytechnic, has a chemistry department which aims at the training of chemical technologists at different levels to meet the local need.

INDONESIA

Chemical research in Indonesia began on a solid basis of Indonesia's natural resources. Products researched included latex and rubber, citronella and other natural products, ceramics, leather, and batik. Certain oil products are of interest; these include natural oil, such as castor oil, sesame oil, sunflower oil, as well as petroleum and petrochemistry. There are certain radiochemistry interests and thermal neutron activation analysis appears to be well developed. There is now an emphasis on developing analytical chemical techniques for Indonesian needs.

IRAQ

The Iraqi Chemical Society publishes a journal whose papers are refereed outside the country prior to publication. The research publications come mainly from the university faculty and are heavily supported by local financial resources.

KOREA

Chemistry research in universities gets only minor support from the Ministry of Education (in contrast to Japan, for example). However, chemistry is strong at the Korea Institute of Science and Technology (KIST), which has been described earlier in this *Bulletin* (Volume 1, No. 2; Volume 3, No. 4; Volume 4, No. 4). The *Bulletin* also had an article on the Korea Research Institute of Chemical Technology (KRICT), which was established 1976. Industrial research is said to be strong in Korea. Subject areas include textiles, fertilizers, cement, paper, ceramics, leather, food, and pharmaceuticals, as well as petrochemicals. There also is a special graduate school, the Korea Advanced Institute of Science (KAIS), which specializes in educating scientists and engineers. KAIS also has been reported on previously in the *Bulletin*.

MALAYSIA

Chemistry research in Malaysian universities is mainly in the areas of applications such as natural products, rubber, palm oil, tin, and pollution. There are number of mission-oriented government agencies. They are mainly interested in product development, quality control, and better utilization of local raw material.

The activities in the Rubber Research Institute include plant, soil, and agricultural chemistry, rubber chemistry (modification, analysis, latex, etc.), chemical aspects of rubber technology, and effluent treatment chemistry. The Malaysian Agricultural Research and Development Institute is interested in pesticide studies, soil and palm oil chemistry, feed evaluation, and palm oil effluents. The Standard and Industrial Research Institute of Malaysia is interested in waste-water treatment, palm oil mill effluent, rice hull ash/cement, and biogas technology. The activities in the Forest Research Institute cover sulfate in pulps, adhesives from plants, and timber chemistry. The Geological Survey is involved in ore analysis. The Chemistry Department of Malaysia provides analytical services in all legal cases in the country, and there is also a Palm Oil Research Institute.

The main chemical industries in the country are agro-based, mainly on palm oil and rubber. Industry is not too concerned with research and development for new products and processes.

PHILIPPINES

Chemical research in the Philippines is involved in export-oriented industries, improvement of food production, natural product research, nuclear research, and also in solutions to the energy crisis. Government institutions, such as the University of Philippines, the Natural Research Center, and the National Institute of Science and Technology, will do research for industry on a project or fee basis. Some support for chemical research can be obtained from the National Science Development Board, National Institute of Science and Technology, and other government agencies. Chemists in the Philippines are licensed by a Board of Chemistry under the Philippine regulation commission.

SINGAPORE

Research interests in the two universities include coordination chemistry, fluorine chemistry, organometallics, kinetics, electrochemistry, thermoanalysis, conformational studies, organic synthesis, and natural products chemistry. Applications are made to environmental pollution, food chemistry electrochemistry, development of analytical methodology, and treatment and utilization of waste. There is a severe lack of funds, facilities, technical support, and postgraduate students, but despite these obstacles, about 10 papers per year are being published in international journals.

Various applied research activities in the Department of Scientific Services, a government agency, include the development, modification, and improvement of various analytical techniques; studies on background radiation levels in and around Singapore; the illegal substitution and fortification of oriental medicines by toxic or more potent western medicines; the prevalence and extent of carcinogenic compounds in plastic food containers, and edible oils. The studies have led to either enforcement action or to the framing of legislative measures. The department also undertakes R&D work for the private sector in such areas as treatment of trade effluents, design of treatment plants, product development, and the formulation and substitution of raw materials. The Singapore Institute of Standards and Industrial Research is engaged in the fields of electroplating, pollution control systems, non-destructive testing and welding techniques, enamelling, and the recovery of tin from scraps.

Chemical industry in Singapore is relatively small, consisting of few companies manufacturing chemicals such as sulfuric acid, hydrochloric acid, sodium hydroxide, chlorine, alums, and PVC resins. The large $1-billion petrochemical complex, which is the joint venture between the Singapore government and Japanese petrochemical companies led by Sumitomo, is expected to be completed in 1982. The upstream company is expected to produce 300,000 tons of ethylene and 165,000 tons of propylene for supply to the downstream companies, which are expected to produce ethylene glycol, low-density polypropylene, high-density polyethylene, and vinyl chloride monomer. The complex is expected to generate about 2000 jobs when in full operation, and a considerable number of professional staff would be chemists who are indispensable especially for the downstream companies.

SRI LANKA

An intensive research program on natural products has existed at Peradeniya University since 1968. It is supported by the National Science Council of Sri Lanka and the U.S. Department of Agriculture under Public Law 480. Over 125 endemic plants have been chemically studied. Over 200 natural products have been identified; 50 of them are new ones whose structures have been elucidated. Other research projects at Peradeniya are the isolation of phytoalexins from tropical plants, research on seaweeds, studies on endemic plants of the families *Apocynacae* and *Rubiaceae*, and studies on graphite, apatite, ilmenite, monazie, and mineral clays of Sri Lanka. Other projects at Peradeniya include perfumery substitutes from local plants, preparation of physiologically active steroids by modification of naturally occurring plant materials, physiochemical properties of natural lattices in Sri Lanka, hepatoxicity of pyrrolizidine alkaloids and the toxicity of palmyrah flour, and complexing properties of 8-hydroxyquinoline-4-carboxyaldehyde. A program sponsored by the World Health Organization is looking at the isolation of fertility-regulating compounds from plants.

At the University of Colombo, research interests include coordination chemistry of heavy metal chelates, marine natural products chemistry, electrochemical problems in industry, electrochemical syntheses, corrosion and passivation of mechanically damaged surfaces, and corrosion protection of mild steel, rail steel, copper, and aluminum in saline atmospheres.

FACS ACTIVITIES

Professor Kamchorn Manunapichu, chairman of the chemistry department of Mahidol University in Bangkok, was elected the first chairman of the Federation of Asian Chemical Societies. Professor Kamchorn (Thais are addressed by their first names, because the last names are unpronounceable when reduced to our 26-letter alphabet from their 44-consonant, 21-vowel, 11-diphthong alphabet) had taken the initiative in forming the federation with the help of a UNSECO grant. An asset which other administrators might envy is that one of his graduate students is the youngest daughter of Thailand's King. The presence of H.R.H. Princess Chulabhorn put the formal opening of the federation meeting on television, something which chemistry by itself does not usually achieve.

The first activity of the Federation of Asian Chemical Societies will be the publication of a newsletter. It is intended that the newsletter will be issued every two months, starting in September, 1979. Among the contents of the newsletter are expected to be

a) news of conferences and symposia in the region,
b) activities of the member societies and the federation,
c) names of distinguished chemists passing through, and
d) summaries of technical reports.

It is seen that the newsletter will be a valuable contribution to the sharing of resources in the area.

Another important activity of the federation is the establishment of several working groups. The following working groups, together with the countries which will chair them, have been established:

Education	Philippines
Book on development of chemistry in Asia	India
Professional affairs	Australia
Environment	Indonesia
Food	Thailand
Directory of expertise and equipment	Hong Kong.

Finally, the following additional countries will be asked to join the federation: Japan, People's Republic of China, Bangladesh, Pakistan, Nepal, New Zealand, Syria, Jordan, Burma, and Iran.

LIST OF ATTENDEES

- Professor Kamchorn Manunapichu
  (President, Chemistry Section,
  Science Society of Thailand)
  Department of Chemistry
  Faculty of Science
  Mahidol University
  Bangkok 4, Thailand

- Mr. Peter W. Woodhouse
  (Executive Secretary, Royal
  Australian Chemical Inst.)
  191 Royal Parade
  Parkville 3052, Victoria
  Australia

- Dr. H. M. Chang
  (Vice President, Hong Kong
  Chemical Society)
  Dept. of Chemistry
  Chinese University of Hong Kong
  New Territory, Hong Kong

- Professor D. O. Jordan
  (President, Royal Australian Chemical Inst.)
  Dept. of Physical and Inorganic Chemistry
  University of Adelaide
  Adelaide, South Australia 5001
  Australia

- Professor Jack R. Cannon
  (Member, Royal Australian Chemical Inst.)
  University of Western Australia
  Nedlands, W. A. 6009
  Australia

- Professor D. P. Chakraborty
  (Honorary Secretary, Indian Chemical
  Society)
  Dept. of Chemistry
  Bose Institute
  Calcutta 700009, India

- Dr. Mohammad Ridwan
  (Vice-Chairman, Indonesian Chemical
  Association)
  Himpunan Kimia Indonesia Jakarta
  Universitas Indonesia
  Fakultas Ilmu Pasti dan Ilmu Alam
  Jurusan Kimia
  Jalan Salemba 4
  Jakarta, Indonesia

- Dr. Mahdi Hussain Hnoosh
  (Acting President, Iraqui Chemists Assn.)
  Iraq National Oil Co.
  Khallani Square
  Baghdad, Iraq

- Professor Kai Cheong Chan
(Vice President, Malaysian Inst. of Chemistry)
Dept. of Chemistry
University of Malaya
Kuala Lumpur, Malaysia

- Dr. Sadik Mahdi Kubba
(President, Iraqi Chemical Society)
Iraqi Chemical Society
Damascus Street
Baghdad, Iraq

- Professor Sang Up Choi
(Former President, Korean Chemical Society)
Sogang University
C.P.O. Box 1142
Seoul, Korea

- Dr. Mohinder Singh
(Honorary Secretary, Malaysian Inst. of Chemistry)
Rubber Research Inst. of Malaysia
P.O. Box 150
Kuala Lumpur, Malaysia

- Professor Paz V. Abis
(Executive Secretary, Integrated Chemists of the Philippines, Inc.)
Chemistry Department
Manuel L. Quezon University
916 R. Hidalgo St.
Quiano, Manila, Philippines
and
Chemistry Department
Philippine College of Criminology
631 Sales St.
Manila, Philippines

- Dean Purificacion S. Suaco
(Treasurer, Integrated Chemists of the Philippines, Inc.)
College of Chemistry
Centro Escola University
9 Mendiola St.
Manila, Philippines

- Associate Prof. Keng Yeow Sim
(Former President, Singapore National Inst. of Chemistry)
Chemistry Department
University of Singapore
Bukit Timah Road
Singapore 1025

- Professor Stanley Wijesundera
(Council Member, Inst. of Chemistry, Sri Lanka)
Vice-Chancellor's Office
University of Colombo
94 Thurstan Road, Colombo 3
Sri Lanka

- Assc. Prof. Salag Dhabanandana
(Honorary Secretary, Science Society of Thailand)
Department of Chemistry
Chulalongkorn University
Phyathai Road
Bangkok, Thailand

SPECIAL GUESTS

- Dr. Wolfgang Fritsche
(Honorary Secretary, Federation of European Chemical Societies)
Gesellschaft Deutscher Chemiker
Varrentrappstrasse 40/42-Postfach 900440
D-6000 Frankfurt 90, FRG

- Dr. Rudolph J. Marcus
(Scientific Director, Scientific Liaison Group)
Office of Naval Research
American Embassy
10-5, Akasaka 1-chome
Minato-ku, Tokyo 107, Japan

- Assoc. Prof. Pimol Rienvatana
  Chemistry Department
  Chiang Mai University
  Chiang Mai, Thailand

- Mr. Hiroshi Hamada
  Secretary General, Chemical Society
  of Japan
  1-5, Kanda-Surugadai
  Chiyoda-ku, Tokyo 101
  Japan

- Asst. Prof. Samran Bhu-anantanondh
  Department of Chemistry
  Faculty of Science
  Khon Kaen University
  Khon Kaen, Thailand

- Asst. Prof. Pichaet Wiriyachitra
  Dept. of Chemistry
  Prince of Songkla University
  Haad Yai
  Songkla, Thailand

BRANCH-SESSION MEETING OF THE PHYSICAL SOCIETY OF JAPAN

Leon H. Fisher

FOREWORD

This report describes the mechanics of meetings of the Physical Society of Japan (JPS). It also attempts to give a picture of the emphasis of present-day Japanese physics as gleaned from the distribution of papers at a recent JPS meeting.

NATURE OF JPS MEETINGS

The JPS holds two meetings each year, one in the spring and one in the fall. The meetings are always held on university campuses; one of these two meetings is referred to as the annual meeting and the other as the branch-session meeting. The annual meeting is held at some large university in a large city (or sometimes at two universities in the same city). The annual meeting is held every other year in Tokyo. The branch-session meeting is held simultaneously in two or more small universities in two or more small cities, the cities being separated by a considerable distance. Presumably, the branch-session meetings are held at small universities in order to stimulate research in such places and to acquaint physicists in large universities with the facilities and programs at smaller, and relatively isolated, universities. Some years the annual meeting is held in the spring and the branch session is held in the fall; other years the arrangement is just the reverse.

There is very little difference in the nature of the two kinds of meetings. The attendance is about the same. At the annual meeting, a member may orally present only one paper; however, he may be the co-author of as many papers as he pleases. The time for presentation of a contributed paper at the annual meeting, including discussion, is ten minutes. At the branch-session meeting, a member may orally present as many papers as he pleases. The time for presentation of a contributed paper at a branch-session meeting, including discussion, may vary from five to 20 minutes (most are ten minutes), the time being determined by the appropriate organizing committee of the subdiscipline in which the paper lies. All contributed papers in any one subdiscipline have equal times allotted. Some contributed papers are presented at poster sessions at both annual and branch session-type meetings. (Poster sessions were introduced at JPS meetings several years ago after some members had seen them in operation in the United States.) Post-deadline papers are allowed at the branch-session meeting, but not at the annual meeting. Papers are not refereed at either type of meeting (as is the case at the large general meetings of the American Physical Society).

The fall 1979 meeting was of the branch-session type. It was held October 2-5 at Kochi University in Kochi, Kochi Prefecture, and at Ehime University in Matsuyama, Ehime Prefecture.

NATURE OF CITIES IN WHICH THE MEETING WAS HELD; THE ISLAND OF SHIKOKU

The cities of Kochi (population 264,000) and Matsuyama (population 350,000) are both on the island of Shikoku. Kochi is on the Pacific Ocean, and Matsuyama lies on the Inland Sea. Kochi and Matsuyama are connected by bus over tortuous mountain highway; the journey takes three and a half hours (to cover a geographical separation of 80 kilometers) and goes through what must be some of the most beautiful and unspoiled countryside of Japan.

Shikoku is the smallest of the four principal islands of the Japanese archipelago. It is somewhat off the beaten path and is relatively isolated. (The last time that a meeting of the JPS was held on Shikoku was 1970.) Shikoku is sparsely populated compared to most of Japan. This relatively idyllic condition is to be short-lived. The Japanese government has made plans to build three bridges to link Shikoku with the Japanese mainland (island of Honshu) across the Inland Sea. In fact, one of these projected bridges has been under construction since October 1978, and the cost will be about $4 billion. The Inland Sea is a national park; the building of these bridges will do much harm to the natural beauty of the area.

NATURE OF THE HOST UNIVERSITIES

Kochi and Ehime Universities (named for the prefectures in which they lie) are both national universities. This means that their support comes entirely from the Japanese government, in contrast to prefectural and private universities which receive partial support from the government. Ehime and Kochi Universities have enrollments of about 5,900 and 2,300, respectively. Both of these universities are quite small by Japanese standards. Ehime University offers a master of science degree in physics, and there are 32 graduate students presently enrolled in this program. Kochi University offers no graduate work in physics. (Three contributed papers from Kochi University and 12 from Ehime University were presented at the meeting. More on these papers later.)

REGISTRATION STATISTICS

The official figures of the society give the registration at Kochi as 570 and that at Matsuyama as 1,952. About 100-150 members attended the meeting at both locations. The registration represents about 23% of the 11,000 members of the society. (The United States, with about twice the population of Japan, had a membership of 28,579 in its American Physical Society as of December 1976.)

PROGRAM BOOK OF THE MEETING

The registration fee was ¥500 (about $2.25) and entitled the registrant to attend both parts of the meeting (Kochi and Matsuyama) and to receive a copy of the program. The programs were not available before the meeting.

The following statement enclosed in a rectangle, appears on the meeting program and on every program of the JPS. (The statement is translated from the Japanese.)

> At the 33rd extraordinary general meeting in September 1967, when discussion was held on the use of United States military funds for support of the International Conference on Semiconductors (held in Japan), the Physical Society of Japan passed the following resolution (No. 3): "The Physical Society of Japan does not accept any support or any other cooperation with military forces of our country or any foreign country." On the occasion of our branch session meeting, the Society asks for your compliance to the above resolution.

Members of the society whose work is supported by, or who work for, the Japanese Self-Defense Forces are not free to present papers at the meetings of the Society. (In 1973, objections prevented the attendance of a member of the Jason Committee of the United States from attending an international conference at the Institute for Nuclear Study, University of Tokyo.) In the three months that I have been in Japan, I have visited universities and research institutes and have been warmly received in the offices of the JPS. I was cordially welcomed and received at one university by a member of the council of the JPS, despite the statement quoted above. As far as this office is aware, the JPS is the only Japanese scientific society that has passed such a resolution.

The program contains the titles, authors, and times of the three kinds of papers (contributed, symposia, and

special lectures) presented at the meeting at both Kochi and Matsuyama. Time for discussion is allotted after every symposium paper but not for special lectures. The program does not contain abstracts.

ABSTRACT BOOKLETS

Papers may be presented without abstracts having been submitted. The abstracts submitted were published in four volumes totalling 960 pages. Members who wish to have one or more of these volumes of abstracts in advance of the meeting were required to order them at least 20 days before the meeting. (There is a substantial charge for the abstracts.) The abstracts were also available for purchase at the time of registration. It is estimated that 60-70% of the attendees purchase abstract books. There are no author indices, either in the program or abstract booklets.

NON-TECHNICAL MEETINGS

In addition to the technical sessions of the meetings of the society, a large number of non-technical informal sessions are scheduled for the various fields of physics. Any one field of physics may have as many as three informal sessions scheduled: an executive meeting (usually small but open to all), a meeting for younger workers, and a large general meeting. These informal sessions are devoted to a discussion of what projects, facilities, and equipment in a particular field of physics should be recommended to the Government for support, and how research facilities should be improved. Such sessions lead to the writing of proposals for implementing the recommendations. These recommendations state how the research funds should be distributed to universities and research institutes, and are first transmitted to the JPS, which, in turn, submits them to the Science Council of Japan (JSC). The Science Council of Japan, in turn, submits them to the source of all educational support in Japan, the Ministry of Education. These policy planning sessions at the meetings of the society may last as long as five hours and are partly social in nature. As few as ten or as many as 100 people may be present at these sessions.

NATURE OF TITLES, ABSTRACTS, AND PRESENTATIONS

There are no rules about the use of Japanese or English for titles, abstracts, or presentations. Titles of papers are almost always in Japanese; often a few English symbols or technical terms appear. Abstracts are almost always in Japanese, or Japanese with a slight admixture of technical terms in English. Japanese authors occasionally submit their titles and abstracts in English, but their talks are always given in Japanese. Non-Japanese authors give titles and abstracts in English, and of course the presentation of such papers are always in English.

Abstracts for contributed papers are submitted on a standard form containing blocks for 1,000 Japanese characters. These abstracts are almost always written by hand (Japanese typewriters have 3,000 keys and the typing speed on them by an experienced operator is about one character per second. It takes about 20 minutes for an operator to type a page in Japanese.) Authors often insert tables and/or graphs and/or photographs of oscillograms and/or diagrams in the abstract (reducing the space available for writing). Tables and labels of graphs are almost always in English, as are references. Each abstract seems to reflect the personality(ies) of its author(s). The variety of abstracts remind one of the infinite ways in which the Japanese arrange flower (ikebana). Those abstracts which are in English are about 200 words in length. It is my impression that JPS abstracts present much more information than do those of the American Physical Society, largely due to the presence of tables, graphs, and oscillograms.

THE PAPERS

Twenty-five special lectures, 93 symposium papers (in 13 symposia), and 1,917 contributed papers were presented in seven simultaneous sessions at Kochi and 21 simultaneous sessions at Matsuyama.

Special Lectures

The special lectures varied in length from 40-60 minutes. Nine of the 25 had abstracts. The following five special lectures were given in English by four Americans and one West German[1]:

- "Classical many body model for nuclear collisions at intermediate and high energies," Lawrence Wilets, University of Washington, Seattle;
- "Confinement of quarks in nuclear matter," Gordon Baym, University of Illinois, Urbana;
- "Electron collisions with atoms and molecules in gas discharges," Arthur V. Phelps, Joint Institute for Laboratory Astrophysics, Boulder;
- "New methods for computing electron scattering and photoionization cross sections," Howard S. Taylor, University of Southern California, Los Angeles; and
- "Electron capture by fast projectile ions," Jorge K. Eichler, Hahn-Meitner Institut, Berlin.[2]

I heard the first two special lectures, which were very well received, and it was apparent that the audience followed the English. Despite the rule of no discussion for special lectures, there was considerable discussion after both papers.

The distribution of the other 20 special lectures by fields was as follows: elementary particle theory, seven; nuclear theory, two; cosmic rays, three; magnetism, one; magnetic resonance, one; macromolecules, two; applied mathematics, dynamics, physics of fluids, two (they had the surprising titles "Random variation of glacier flow and ice age" and "Dispersion of material at sea coast areas"); plasma physics, atomic fusion, two.

Symposium Papers

The number of papers per symposium varied from two to 12, and the time for presentation, including discussion, varied from 15-100 minutes per paper. For some of the symposia, ten minutes of introduction and ten minutes of summary were scheduled to be given by the chairman of the session.

The titles of the symposia follow:

1. "Report on Lepton and Photon International Conference held at Fermi National Accelerator Laboratory, Batavia, in August, 1979";
2. "The role of isobars in the nucleus";
3. "International co-operative research projects in high energy physics";
4. "Intermediate and high energy nuclear experiments in Japan (present and future possibilities)";
5. "Structural phase transitions and dispersion of sound waves";
6. "Abnormal conductivities in semiconductors in the presence of magnetic fields";
7. "Photoelectric spectroscopy";
8. "Picosecond spectroscopy, present and future";
9. "High resolution transmission electron microscopy";
10. "Sound waves in liquid helium";
11. "Asymmetrical Anderson model";
12. "Phonons in liquid helium"; and
13. "Next step for nuclear fusion."

A few comments on some of the symposia follow. Symposium 1 covered the conference at which the discovery of the gluon was announced. This symposium consisted of two papers, each 100 minutes in duration, given by Y. Hara (experimental) and J. Nagashima (theoretical), both of Tsukuba University. Symposium 2 consisted of four theoretical papers. Symposium 3 consisted of 12 papers, given by Japanese experimental physicists, who had worked in high-energy laboratories in the United States and Europe with partial support of the Japanese Government. The speakers were from the following universities: Tohoku, Kobe, Tokyo Metropolitan, Tokyo, Nagoya, and Tsukuba, as well as from KEK, the National Laboratory for High Energy

Physics (KEK is an acronym for Ko Energy Kenkyusho; ko means high and kenkyusho means study place; KEK is located in the new academic city of Tsukuba, about 60 kilometers northeast of central Tokyo.) Among the laboratories at which the work reported was carried out are Brookhaven National Laboratory, Fermi National Accelerator Laboratory, and the Stanford Linear Accelerator.

Symposium 4 consisted of six experimental papers. One paper described work carried out with the electron synchrotron at the Institute of Nuclear Study (INS) at the University of Tokyo. Another paper described cooperative research carried out with the BEVELAC at the Lawrence Berkeley Laboratories; still another described nuclear experiments at KEK. One paper discussed the future profile of nuclear physics in Japan, including the projected big machines as well as the NUMATRON. (NUMATRON is an acronym for "nuclear matter accelerator" and is a machine proposed by INS for the acceleration of large currents of highly stripped heavy nuclei up to completely ionized uranium with energies up to about 1.3 Gev per nucleon. The accelerator system would consist of an injector of Wideröe and Alvarez linear accelerators and two synchrotron rings of 34 meters radius. A partially stripped beam of heavy atoms would be stacked in the first ring, accelerated to 150 Mev per nucleon, extracted, and passed through another stripper, and accelerated to the final energy in the second synchrotron.) Other machines proposed by Osaka University and by the Institute of Physical and Chemical Research, Wako-shi, Saitama, were also discussed. Another paper discussed nuclear experiments using π-μ particles.

Contributed Papers

One can get some further idea of the present interests of Japanese physicists from the distribution of the contributed papers by discipline, as shown in Table I. One notices the enormous effort in Japan in magnetism and plasma physics. Also listed in Table I are the percentages of papers having abstracts by discipline. Note the low percentage of abstracts submitted by elementary particle physicists, nuclear theorists, and cosmic-ray workers. The times for presentation of papers, and the volume number in which the abstracts appear, are also given in case any one wants to order the abstract books (Physical Society of Japan, Room 211, Kikai-Shinko Building, 3-5-8, Shiba Koen, Minato-ku, Tokyo 105, Japan).

Papers Presented by Host Universities

It is interesting to list the titles of the contributed papers given by authors from Kochi and Ehime Universities to give an idea of what kinds of research are being carried out in smaller universities in Japan. (These universities have much larger teaching loads than the major ones.)

Kochi University

- "Shell model calculation of $g_{9/2}$ shell nuclei";
- "Structure of the air shower core (experimental)"; and
- "α-Mn nuclear magnetic resonance" (co-author from University of Tokyo).

Ehime University

- "Time structure of muons and electrons in the air shower observed on Mt. Chacaltaya and its interpretation" (co-authors from seven other universities, including one in Bolivia and one in Hong Kong);
- "Secondary lattice defect density in quenched aluminum and its speed of quenching" (co-author from Hiroshima University; Hiroshima is a one hour boat trip from Matsuyama);
- "Production of Al single crystal by means of heat cycle annealing" (co-authors from Hiroshima University);
- "Phase diagram and phase separation of high pressure He-Kr gas mixture-ultrasonic wave method";
- "Magnetic anisotropy of Ni-Ir alloy" (co-authors from Hiroshima University);

- "Magnetic anisotropy and magnetoresistance of Ni alloy crystals" (co-authors from Hiroshima University);
- "Radiation pressure of sound wave acting on elastic sphere";
- "Area and ambient length of discrete diagram" (mysterious title; paper in applied mathematics section);
- "Electronic heating in plasma systems;
- "Amplitudes of higher harmonics in electron cyclotron resonance";
- "The effect of atom-atom collisions on inversions in recombination plasmas" (co-authors from Hiroshima and Okayama Universities); and
- "An experimental study of inverted population density in recombination plasmas" (co-authors from Hiroshima and Okayama Universities).

Case History: A Contributed Paper in Detail

A detailed report is given of one contributed paper as an example. The title is "High order perturbation for deep hole states" by N. Onishi and T. Toyama of the University of Tokyo. The authors consider that an electron or proton is incident on a nucleus ejecting a nucleon and leaving a hole in the nucleus. This nucleus, with a moving hole, may be referred to as state A. State B is the same system with two holes in the nucleus and a nucleon in a particle orbit above the Fermi levels, outside the nucleus with two holes. The width of level A corresponding to the decay into state B was calculated and found to be about 5 Mev wide for 0^{16}. The calculations used the Hartree-Fock method and included the Yukawa force and the three-body Skyrme force. (The Skyrme force is a three-body force not covered by the Yukawa potential.) The calculation was made on the unperturbed state A and involves nonlinear equations. Then the coupling between states A and B was calculated by using the interactions used in the above Hartree-Fock calculation. Thus the calculations were made for 0^{16} shell structure, and the energy levels were filled up to 16 orbits. Then one nucleon is removed and the calculation of the coupling of the one-hole state to the two-hole, one-particle state is made, and, from that, the width of the A state is obtained. Even though B has a width due to its own instability, the width of A was only calculated for state A decaying to B states. The incident particle is assumed to have a high energy compared to the orbital nucleon motion. The incoming energy is taken to be about 200 Mev, compared to the orbital nucleon energy of 15-30 Mev. The theory is general, but calculations have only been made for 0^{16}. The width of the hole state is important in order to clarify transport phenomena in the nucleus. This calculation can be compared with the spectra of the reactions (e; e', p) and p, 2p).

Contributed Papers on TARN

Eight contributed papers were given on TARN. TARN is the acronym for Test Accumulation Ring for NUMATRON. TARN is a storage ring of about 5 meters radius which has been built to test principles on which the NUMATRON is based. The titles of the papers are (roughly): TARN construction report, total operation test; TARN vacuum test; Calibration of six-pole magnet; Beam-transfer system; Pulsed magnet; Multibeam system; Beam monitor; High-frequency accelerator. Vacua of 10^{-9} Torr have been obtained in the ring.

Contributed Papers with English Titles

- "Cabibbo-suppressed" D decays and $(\bar{C}\,S)_R$ current
- Cosmological amount of baryons
- Dual topological unitarization (DTU)
- Neutral-current effects in lepton pair production with polarized photons
- Running coupling constant
- Nonstatic effects of constituents quarks
- Energy-momentum tensor in the fermion-pairing model
- Inelastic electron scattering from pf-shell nuclei
- Theory on electron cooling
- Achromatic geminate nuclear electron separator (AGNES)

- Excitation functions of $^{197}Au(\alpha, 2n)^{199}$ and $^{197}Au(\alpha, 2p)^{199}$ reactions
- α-n correlation measurement by (α, α') reactions
- De-excitation processes for (α, xnpγ) reactions
- Pion absorption by nuclei
- Effective coupling constants for E1 transitions in A ~ 90 nuclei
- Analyzing power for the p̄-nucleus elastic scattering in the small angle region
- EO transition in ^{106}Pd
- Stimulated photon echo modulation
- Laser induced population grating (LIPG)
- Growth of Z centers in LiF:Mg crystals by X-irradiation
- Mutual drag effect and Righi-Leduc effect in antimony
- A variational approach to dynamics of ionic crystals at high temperatures
- On stability of flow down along a vertical cylinder
- Analysis of the Navier-Stokes equations based on Green's function
- Toroidal effect on non-local drift instability
- Passive feedback control in a Tokamak
- Electromagnetic drift wave turbulence and convective cell formation.

FUTURE MEETINGS

The next annual meeting of the JPS will be held in March, 1980, at Waseda and Gakushuin Universities in Tokyo. The next branch-session meeting will be held in October, 1980, at Fukushima and Fukui Universities in the cities of the same name. These two cities are widely separated. The annual meeting in 1981 will be held at Hiroshima University.

Table I

Contributed Papers by Discipline at JPS Branch-Session Meeting

	Number of Contributed Papers	% with Abstracts	Time Per Paper Including Discussion	Volume of Abstracts
Elementary Particle Theory	87	29	10	I
Experimental Elementary Particle Physics	62	37	10	I
Nuclear Theory	46	43	15	I
Experimental Nuclear Physics	114	92	10	I
Cosmic Rays	47	19	10	I
Crystal Growth	17	100	10	II
Lattice Defects	63	100	10	II
Dielectric Materials	92	98	10	II
Semiconductors	118	98	7	II
Ionic Crystals, Optical Properties of Matter	112	99	7	II
Molecular Crystals, Liquid Crystals, Organic Semiconductors	40	98	10	II
Quantum Electronics	42	98	10	II
X-rays, Low Energy Electron Diffraction, Neutron Scattering	69	87	10	II
Nature of Sound Waves, Acoustics	12	100	10	II

Continued

Table 1–Continued

Contributed Papers by Discipline at JPS Branch-Session Meeting

	Number of Contributed Papers	% with Abstracts	Time Per Paper Including Discussion	Volume of Abstracts
Radiation Physics	17	94	10	III
Atoms and Molecules	56	98	10	III
Magnetism	216*	99	5	III
Magnetic Resonance	15	100	10	III
Metals	86	100	10	III
Low Temperature	71	92	10	III
Statistical Mechanics, Basic Theory of the Property of Matter	113	93	10	III
Macromolecules	18	94	10	III
Biophysics	10	90	15	III
Applied Mathematics, Dynamics and Physics of Fluids	72	99	10	IV
Electric Discharges	22	100	10	IV
Plasma Physics, Atomic Fusion	300**	98	10	IV

*31 papers presented in poster sessions.
**55 papers presented in poster sessions.

1. All five of these scientists were in Japan for visits sponsored by the Japan Society for the Promotion of Science (JSPS) on short-term research fellowships. JSPS sponsors both short-term and long-term research fellowships, short-term being for periods up to four months and the long-term fellowships for a period of up to a year or longer. The support consists of transportation and a living allowance, but no salary. In 1977-78, the society invited 177 foreign scientists for short-term fellowships in the mathematical, physical and engineering sciences; chemical sciences; biological, agricultural, and medical sciences; and 35 scientists for long-term fellowships in these same fields. JSPS also supports the humanities and social sciences in a similar way.

2. Dr. Eichler's paper described an approach developed by Chan and himself to describe 1s electron capture into fast ($E \gtrsim 50$ kev/amu/Z_t^2) where Z_t is the nuclear charge of the target atom multicharged ions. The approach is based on an eikonal approximation formulated in the impact parameter picture and leads, without further approximation, to a simple analytical formula for the cross section for capture into a given principal shell or n, l subshell. The cross section is smaller by a factor 0.15-0.4 than cross sections drived from the Oppenheimer-Brinkman-Kramers (OBK) approximation and is in agreement with a large variety of experimental data for total cross sections. Also the calculated cross sections from H(1s) into the 2s, 2p, 3s, 3d, and 4s states of H^+ and He^{++} are in good over-all agreement with experimental data. Thus, the theory gives an easily available and reliable estimate of capture cross sections and in this respect should replace the OBK approximation. The results may be useful for fusion research and fusion plasma diagnostics.

THE JAPANESE GEOMORPHOLOGICAL UNION: A NEW SCIENTIFIC ORGANIZATION

H. J. Walker

"It is an honor for me to present the concluding remarks at Japan's first symposium on experimental geomorphology. The symposium was a complete success, our discussions were extremely fruitful, and, in addition, you gave your unanimous approval to the idea of holding such a symposium every year from now on. However, I think the most dramatic event has been the establishment of the Japanese Geomorphological Union. After founding it in the course of the sake party last evening, we soberly confirmed it at the business meeting this afternoon. We have all sworn to contribute our all-out effort in its behalf.

Our Union, the establishment of which has long been desired, brings together geomorphologists, geophysicists, geochemists, agricultural engineers, civil engineers, pedologists, and others with common geomorphological interests...

I am firmly convinced that October 6th and 7th, 1979, will be remembered as important days in the history of geomorphology in the world."

With loud applause, the forty individuals present in the audience indicated their agreement with this statement as presented by Professor Eiju Yatsu and, in doing so, gave the final stamp of approval to the founding of the Japanese Geomorphological Union.

GEOMORPHOLOGY IN JAPAN

In Japan, as in most countries, research in geomorphology is conducted within many disciplines—a fact that was important in the creation of the new union. Usually the two fields with the greatest number of practicing geomorphologists are geography and geology. In Japan, as in England, most academic geomorphologists are in the departments of geography rather than geology, and about four times as many geomorphological articles are published in geographical as in geological periodicals. The interest in geomorphology in Japan among geographers was clearly indicated at the April, 1979, meeting of the Association of Japanese Geographers (AJG) in Tokyo, when 30% of the 138 papers on the program were geomorphological in content.

Geomorphologists in Japan emphasize research in volcanic, tectonic, climatic, and coastal geomorphology, not a surprising emphasis, given the nature of the country. Some interest is also expressed in regional, historical, and experimental geomorphology—the latter being the theme of the meeting reported in this paper. Those interested in more details about Japanese geomorphology are referred to a paper by Drs. Yoko Ota and Michio Nogami, entitled "Some Recent Research in Japanese Geomorphology." It appeared in Vol. 31 of the *Professional Geographer*, a U.S. periodical, in June, 1979.

EXPERIMENTAL GEOMORPHOLOGY: THE SYMPOSIUM

At the April, 1979, meeting of the AJG, about 25 geomorphologists met as an interest group as had been done many times before. During the session, it was decided to initiate a series of symposia, each devoted to some specific geomorphological topic. It was agreed to launch the series with a 1½ day meeting devoted to experimental geomorphology.

The arrangements were made by Setsuo Okuda, Professor of Applied Geomorphology in the Disaster Prevention Research Institute (DPRI), Kyoto University. The chairman, the location, and the timing were all appropriate for the topic of experimental geomorphology. First, the DPRI is a research unit that contains specialists trained in a variety of sciences, unlike most departments of geography and geology, who share an interest in geomorphology; second, being a research organization, some members have emphasized experimental research; and third, S. Okuda and his colleagues recently participated in the regional meetings of the International Geographical Union's Commission on Experimental Geomorphology held in Krakow and Paris.

The symposium attracted between 50 and 60 participants from many institutions around Japan. The largest number was from the DPRI, the second largest, from the University of Tsukuba. Other representatives came from as far away as Hokkaido and Okinawa, although the bulk of the remainder were from universities in the Kansai area (Kyoto, Osaka, and Kobe, for example).

The scientific portion of the symposium consisted of 19 papers presented during five two-hour sessions. The papers ranged widely in content; two were reports on international experimental geomorphology conferences, two detailed research in experimental geomorphology in China and North America (especially Canada), and 15 were substantive research papers. Their authors represented geochemistry, geophysics, climatology, hydrology, pedology, geology, and geography.

Nearly all of the substantive papers treated research that is being conducted on Japanese terrain, although C. Nakajima, a climatologist, and former director of the DPRI, dealth with his research on typhoons in West Pakistan. A few examples will show the diversity of the topics covered and the logic which lies behind the formation of a separate scientific organization to treat geomorphologic topics.

H. Ikeda and F. Iseya, University of Tsukuba, presented the results of their riverine bedform and sediment transport studies. They reported that the geometry of the dunes formed on the bed of the Teshio River, Hokkaido, is related to stream power. They also noted that the upward flow velocity in the river's kolks is about 5-6 cm/sec. This value was determined by measuring the size of the sediment grains carried in the kolks and then calculating what their fall velocity would be in non-turbulent flow.

A paper by S. Okuda and H. Suwa, DPRI, treated the geomorphic effects of debris flow. Their field location is a large gully cut into the slope of Mt. Yakedaki, an active volcano in the northern Japan Alps. They found that the gully's bottom height is highly variable and is affected by debris supply from valley walls, accumulation and melting of snow, and erosion or deposition by debris flow within the gully.

R. Yoshioka, DPRI, a geochemist, analyzed the relationships among concentrations of the major dissolved constituents in a landslide area. With water samples collected through tubes that were placed in the now-protected area, he has attempted to reconstitute the original minerals by back-reaction of ground water and weathering products.

Y. Matsukura and E. Yatsu, University of Tsukuba, described the equipment, much of it fabricated at the university, they are using in their study of the swelling pressure of shales and tuffs upon wetting. They proposed a method of calculating the intrinsic energy involved in swelling.

H. Yamamoto, H. Kadomura, and K. Suzuki, University of Hokkaido, presented some results from their work on the ash falls that have occurred since the 1977 eruption of Mt. Usu, Hokkaido. T. Mizuyama, Kyoto University of Education, reported on his detailed measurements of the formation and growth of rills on the slopes of weathered Paleozoic rocks in Kyoto Prefecture. The report emphasized the correlation between rainfall intensity and the properties of the materials forming the slopes.

As is the case at most of the earth-science-related meetings I have attended in Japan, most of the papers were illustrated by 35-mm slides. Nearly all of those slides that contained diagrams or maps were captioned in English, another common practice in Japan.

Paper presentations were followed by a discussion that considered several aspects of experimental geomorphology. One specific topic dealt with the speed of landform change and with the techniques that should be used in surveying such change. It was noted that, although fast-changes can be observed and measured, it is difficult to determine how to translate this information to slow-changes. The related question of how long surveys should be continued was also discussed. It was suggested that observations should continue through several professors in sequence—50-100 years, at least.

Another topic was teamwork in geomorphologic research. Should the research be done by few or by many? Most university departments cannot mount elaborate research programs (a situation that is well known in the United States) or are limited generally to research conducted with a small number of people, many of whom must be students. On the other hand, groups such as the Ministry of Construction and Ministry of Transport can initiate major efforts. Most experimental studies, it was pointed out, need continuous support over a "long" period of time, a condition that is difficult to satisfy at university department level.

In closing this discussion, the point was made that the most important problem of all is how to take the experimental data collected and convert them into prediction models. Discussion on this problem was deferred to the next meeting.

THE BUSINESS MEETING

The business meeting proper began with T. Suzuki, Chuo University, in charge. Only a few participants had left, despite the fact that it was already late on a Sunday afternoon. All, apparently, wanted to have a part in working out the details in the founding of the new organization.

Actually, there were few new points raised during the 80-minute session, and the Japanese version of the democratic process was utilized. No votes were ever taken. However, each decision was given group approval by applause. Because the idea of a new organization had already been generally agreed upon, the business meeting was mainly devoted to working out details of organization and management, determining what publications should be issued, and establishing a name.

About 20 minutes were devoted to various organizational and management questions. Because of the complexity and importance of such matters to the future success of the group, it was decided they should first be considered by a committee. Some time was spent on appointing members to the committee, a committee to draft a constitution and handle the affairs of the new organization until formal elections can be held. In Japan such officers are known as "sewanin" (caretakers). There were 12 sewanin appointed: I. Akojima, University of Tokushima (quaternary geomorphology); T. Fujiki, University of Hokkaido (hydrology and periglacial geomorphology); S. Hatano, Geographical Survey Institute (experimental geomorphology); M. Hirano, Osaka City University (theoretical geomorphology); S. Mezaki, University of the Ryukyus (fluvial geomorphology and coralline research); T. Mizuyama, Kyoto University of Education (experimental geomorphology); S. Okuda, DPRI (experimental geomorphology); T. Sunamura, University of Tsukuba (engineering geomorphology); T. Suzuki, Chuo University (volcanic geomorphology); E. Tokunaga, Tokyo Metropolitan University (theoretical geomorphology); Y. Toyoshima, University of Tottori (aeolian geomorphology); and E. Yatsu, University of Tsukuba (experimental geomorphology). These geomorphologists, who represent most of the areas of geomorphology in Japan and also provide a good regional coverage of the country, might be considered a "blue ribbon" group among geomorphologists.

Despite the great importance of such a committee appointment, the topic that elicited the most discussion during the business meeting was that dealing with the publication practices of the new group. Because of the great variety of publishable material a scientific organization can produce and because of the various formats a publication can take, it was decided to issue the material in three forms:

1) a monograph series, sponsored by the new organization, but to be published by selected book companies;

2) a periodical, entitled *The Geomorphological Forum*, which will be issued in volumes, each with several numbers, and will contain original research papers as well as newsletter and review-type articles; and
3) a series entitled *Geomorphological Research*, which will consist of papers on specific themes, such as those delivered at this symposium.

The last item of business was the determination of a name for the new organization. Although the name of Japanese Geomorphological Union was generally agreed on earlier, there was some discussion. At the end, E. Yatsu read the statement used to introduce this article and the new Union was officially established.

If the enthusiasm evidenced by the group present at this meeting is a valid indicator of the future, the dates of October 6th and 7th, 1979, will indeed be remembered in the field of geomorphology as prophesized by Professor Yatsu.

Attendees and Addresses of Participants of Founding Meeting

Japanese Geomorphological Union
c/o Professor Sutsuo Okuda
Disaster Prevention Research Institute
Kyoto University
Gokano-sho
Uji, Kyoto 611
Telephone: (0774) 32-3111

Dr. T. Suzuki
Department of Earth Science
Chuo University
1-13-17, Kasuga
Bunkyo-ku, Tokyo 112

Dr. H. Kadomura
Dr. K. Suzuki
Dr. H. Yamamoto
Department of Environmental Science
University of Hokkaido
Nishi-8-chome, Kita-10-jo
Sapporo, Hokkaido 060

Dr. T. Mizuyama
Department of Geography
Kyoto University of Education
1, Fukakusa-Fujinomori-cho
Fushimi-ku, Kyoto 612

Dr. Y. Toyoshima
Department of Geography
University of Tottori
1-1, Koyama-cho
Tottori, Tottori 680

Dr. M. Nogami
Dr. E. Tokunaga
Department of Geography
Tokyo Metropolitan University
2-1-1, Fukuzawa
Setagaya-ku, Tokyo 158

Dr. Y. Ota
Department of Geography
Yokohama National University
2-31-1, Ohoka, Minami-ku
Yokohama, Kanagawa 233

Dr. T. Fujiki
Department of Geophysics
University of Hokkaido
Nishi-8-chome, Kita-10-jo
Sapporo, Hokkaido 060

Dr. S. Okuda
Dr. H. Suwa
Dr. R. Yoshioka
Disaster Prevention Research Institute
Kyoto University
Gokano-sho
Uji, Kyoto 611

Dr. I. Akojima
Faculty of Education
University of Tokushima
2-6, Niikura-cho
Tokushima, Tokushima 770

Dr. M. Hirano
Faculty of Literature
459, Sugimoto-cho
Sumiyoshi-ku, Osaka 558

Dr. S. Hatano
Geographical Survey Institute
3-24-13, Higashiyama
Meguro-ku, Tokyo 153

Dr. H. Ikeda
Dr. F. Iseya
Dr. Y. Matsukura
Dr. T. Sunamura
Dr. E. Yatsu
Institute of Geoscience
University of Tsukuba
Aza-Amakubo, Ohaza-Tsumaki
Sakura-mura
Niihara-gun, Ibaraki 300-31

Dr. S. Mezaki
University of the Ryukyus
3-1, Shuri-Tohnokura
Naha, Okinawa 903

International Meetings in the Far East
1980–1983

compiled by Seikoh Sakiyama

It is intended to update and augment this list in future issues of the Scientific Bulletin. The assistance of Dr. T. D. C. Grace, Australian Embassy, Tokyo, and Dr. J. M. McNamara, New Zealand Embassy, Tokyo, in supplying a listing of meetings in their countries is deeply appreciated.

1980

Date	Title	Site	For information, contact
January 30-February 2	12th Meeting of Australian Crystallographers	Canberra, Australia	Dr. G. McLaughlan, Research School of Chemistry, ANU, PO Box 4, Canberra, ACT, 2600
February 3-7	Coordination and Metallo-Organic Division (COMO-9)	Sydney, Australia	Dr. I. Dance, School of Chemistry, Uni NSW, PO Box 1, Kensington, NSW, 2033
February 3-8	VII International Thyroid Congress	Sydney, Australia	Australian Academy of Science, PO Box 783, Canberra City, ACT 2601
February 4-8	Australian X-Ray Analytical Association School/Conference	Camberra, Australia	Conference Secretary, c/o NSW Institute of Technology, PO Box 123, Broadway, NSW, 2007
February 5	6th Aust. Conference on Electron Microscopy	Clayton, Vic. Australia	Dr. W.C.T. Dowell, CSIRO, Division of Chemical Physics, P.O. Box 160, Clayton, Vic. 3168
February 10-16	6th International Congress of Endocrinology	Melbourne, Vic. Australia	Aust. Academy of Science, P.O. Box 783, Canberra City, A.C.T. 2601
February 11-23	UN Regional Cartographic Conference for Asia and the Pacific	Wellington, New Zealand	Dept. of Land and Survey Private bag, Charls Fergusson Bldg., Wellington
February 16-21	Australian Dental Association Hobart Convention	Hobart, Australia	Dr. H. Hammer, Chairman, 130 New Town Rd., New Town, Tas., 7008
February 17-20	Conference on Molecular Physics and Quantum Chemistry	Sydney, Australia	Dr. P. G. Burton, Dept. Chemistry, University Wollongong, Wollongong, NSW, 2500

1980 – Continued

Date	Title	Site	For information, contact
February 21-22	The First Gaseous Electronics Meeting	Sydney, Australia	Dr. Richard Morrow, C.S.I.R.O., Division of Applied Physics, National Measurement Laboratory, P.O. Box 218, Lindfield, N.S.W., 2070
February	6th Congress of the Asian Pacific Assn. of Gastroenterology	Auckland, New Zealand	Asian Pacific Congress of Gastroenterology, Department of Gastroenterology, Auckland Hospital Park, Auckland
February	5th Gondwana Symposium	Wellington, New Zealand	Royal Society of New Zealand, Box 12249, Wellington
March 9-10	Migration and Health	Wellington, New Zealand	Wellington Post Graduate Society, Epidemiology Unit, Wellington Clinical School, M.S.R.U.
March 9-14	Australasian Society of Nephrology Annual Scientific Meeting	Adelaide, Australia	Dr. B. M. Saker, Australasian Society of Nephrology, Renal Unit, Royal Perth Hospital, Perth, WA, 6000
March 23-29	17th International Coastal Engineering Conference	Sydney, N.S.W. Australia	Institution of Engineers, 11 National Circuit, Barton, A.C.T., 2600
April 7-10	International Conference and Exhibition on Liquefied Natural Gas	Kyoto, Japan	Dr. Y. Shibazaki, The Japan Gas Association, 38, Shiba-Kotohira-cho, Minato-ku, Tokyo 105
April 7-11	International Conference on Plasma Physics (IUPAP)	Nagoya, Japan	Prof. Y. Ichikawa, Institute of Plasma Physics, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464
April 19-May 8	International Marine Biological Workshop	Hong Kong	Dr. B. S. Morton, University of Hong Kong, Pokfulam Road, Hong Kong
April 29-30	Ninth BMR Symposium 1980	Canberra, Australia	Mrs. E. E. Young, Bureau of Mineral Resources, PO Box 378, Canberra City, ACT, 2601
May 7-9	Foundations on Rock	Sydney, Australia	The Institution of Engineers, Australia, 11 Naitonal Circuit, Barton, ACT 2600
May 12-14	Australian Physiological and Pharmacological Society	Brisbane, Australia	Dr. S. R. O'Donnell, Dept. Physiology, Uni Queensland, St. Lucia, Qld., 4067
May 12-14	4th National Conference of the Australian Plant Pathology Society	Perth, Australia	Dr. G. D. McLean, Department of Agriculture, Jarrah Rd., South Perth, WA, 6151

1980 – Continued

Date	Title	Site	For information, contact
May 12-15	The 3rd International Meeting on Radiation Processing (IMRAP-3)	Tokyo, Japan	Secretariat of (IMRAP-3) Takasaki Radiation Chemistry Research Establishment, Japan Atomic Energy Research Institute, 1233 Watanuki-cho, Takasaki, Gumma, 370-12
May 12-16	Australia-NZ Geomechanics Conference	Wellington, New Zealand	Victoria University, Wellington
May 12-16	Australian Biochemical Society Annual Meeting	Melbourne, Australia	Dr. H. C. Robinson, Biochemistry Dept., Monash University, Clayton, Vic., 3168
May 12-16	ANZAAS Jubilee Congress	Adelaide, Australia	Executive Secretary, ANZAAS, 157 Gloucester Street, Sydney, NSW, 2000
May 12-16	Royal Australian College of Physicians	Sydney, Australia	RACP, 145 Macquarie Street, Sydney, NSW, 2000
May 19-22	4th International Conference on Titanium	Kyoto, Japan	The Japan Institute of Metals, Aramaki Aoba, Sendai 980
May 20-23	Australian Society for Microbiology and the New Zealand Microbiological Society	Dunedin, New Zealand	Australian Society of Microbiology, 191 Royal Pde, Parkville, Vic., Australia, 3052
May 21-30	FAO Indo-Pacific Fishery Commission (IPFC) 19th Session	Kyoto, Japan	Mr. Koji Imamura, Research Division, Fisheries Agency, 1-2, Kasumigaseki, Chiyoda-ku, Tokyo 100
May 26-28	Second Australian Energy Conference	Melbourne, Australia	Dr. D. R. Warren, ARL, GPO Box 4331, Melbourne 3001
May (tentative)	Annual Conference Australasian Institute of Mining & Metallurgy	New Zealand	Mr. L. S. Jones, New Zealand Branch, Australian Institute of Mining and Metallurgy, Box 6342, TE ARO, Wellington
May (tentative)	International Archaean Symposium	Nedlands, W.A., Australia	Dr. J. A. Hallberg, CSIRO, Div. of Mineralogy, Private Bag P.O., Wembley, W.A. 6014
May (tentative)	28th International Congress of Physiology	Australia (undecided)	Assistant Secretary, Aust. Academy of Science, P.O. Box 216, Civic Square, A.C.T. 2608
June 1-3	The 8th International Conference on Oral Biology	Tokyo, Japan	Association of Oral Hygiene, 1-38-6, Komagome, Toshima-ku, Tokyo 171

Date	Title	Site	For information, contact
June 2-6	Joint Conference of Fourth International Congress on Waves and Instabilities in Plasmas and Fourth Kiev International Conference on Plasma Theory (International Conference of Plasma Physics)	Tokyo, Japan	Prof. K. Nishikawa, Faculty of Science, Hiroshima University, 89-1-1, Higashi-Senda-cho, Hiroshima 730
June 5-8	Congress of the International Association for Dental Research	Osaka, Japan	Prof. Y. Kawamura, Dental School, Osaka University, 32, Joan-cho, Kita-ku, Osaka 530
June 9-10	Implantology and Biomaterials in Stomatology	Kyoto, Japan	Prof. H. Kawahara, Osaka Dental College, 1-47, Kyobashi, Higashi-ku, Osaka 540
June 19-20	Regional Meeting for Burn Injuries in Japan	Sapporo, Japan	Prof. Junji Hamamoto M.D., Dept. of Plastic & Reconstructive Surgery, School of Medicine, Hokkaido University, Kita 14, Nishi 5, Kita-ku, Sapporo 066 Headquarters: The International Society for Burn Injuries, 4200 E, Ninth Av. Box C-309, Denver, Colorado 80262, U.S.A.
June 23-26	3rd World Hydrogen Energy Conference	Tokyo, Japan	Japan, Convention Service, Inc., Nippon Press Center Bldg. 8F, 2-2-1, Uchisaiwai-cho, Chiyoda-ku, Tokyo 100
June 30-July 4	The Eighth International Liquid Crystal Conference	Kyoto, Japan	Prof. Shunsuke Kobayashi, Dept. of Electric Engineering, Faculty of Technology, Tokyo University of Agriculture and Technology, 2-24-16, Nakamachi, Koganei-shi, Tokyo 184
June 30-July 4	The Seventh International Congress on Catalysis	Tokyo, Japan	Prof. I. Yasumori, Dept. of Chemistry, Faculty of Science, Tokyo Institute of Technology, 2-12-1, Ookayama, Meguro-ku, Tokyo 152
July 7-11	10th IUPAC International Symposium on Carbohydrate Chemistry	Sydney, Australia	Australian Academy of Science, P.O. Box 783, Canberra, ACT 2601

1980 – Continued

Date	Title	Site	For information, contact
July 9-16	Australian Acoustical Society "Acoustics in the 1980s"	Sydney, Australia	The Australian Acoustical Society, Tenth ICA Executive Committee, The Science Centre, 35 Clarence Street, Sydney, NSW, 2000
July 19-20	ICA-1980 Associated Acoustics Conference	Auckland, New Zealand	ICA-1980 Associated Conference, P.O. Box 1181, Auckland
July 20	10th International Conference on Acoustics	New Zealand	Dr. C. Balachandron, New Zealand Acoustic Society, D.S.I.R. Private bag, Lower Hutt
July 20-August 2	The 2nd International Symposia on Biology and Management of Mangroves and Tropical Shallow Water Communities	Port Moresby, Madang Papua, New Guinea	The Western Society of Naturalists, Prof. David H. Montgomery, Biological Sciences Department, California Polytechnic State University, San Luis Obispo, California 93407 USA
July 22-29	Vth International Symposium on Biological Control of Weeds	Brisbane, Qld. Australia	CSIRO Div. of Entomology, Private Bag 3, Indooroopilly, QLD. 4068
August 3-9	XVI International Congress of Entomology	Kyoto, Japan	Kyoto International Conference Hall, Takara-ike, Sakyo-ku, Kyoto 606
August 18-22	7th Australasian Hydraulics and Fluid Mechanics Conference	Brisbane, Australia	The Institution of Engineers, Australia, 11 National Circuit, Barton, ACT, 2600
August 18-22	5th Australian Electrochemistry Conference	Perth, Australia	Professor A. J. Parker, Murdoch University, Murdoch, WA, 6153
August 18-22	4th International Conference on Production Engineering	Tokyo, Japan	The Japan Society of Precision Engineering, Seramikkusu Bldg., 2-22-17, Hyakunin-cho, Shinjuku-ku, Tokyo 160
August 24-31	The 21st Congress of International Association of Theoretical and Applied Limnology	Kyoto, Japan	Assistant Prof. T. Miura, c/o Otsu Hydrobiological Station, Kyoto University, Shimosaka-Honmachi, Otsu 520-01
August 25-29	8th Asian Congress of Pharmaceutical Sciences of the Federation of Asian Pharmaceutical Associations	Kyoto, Japan	Japan Pharmaceutical Association 2-12-15-701, Shibuya, Shibuya-ku, Tokyo 150 Headquarters: The Federation of Asian Pharmaceutical Associations (FAPA), Hizon Bldg., 29 Quezon Bd., Quezon City, Phillippines

1980 – Continued

Date	Title	Site	For information, contact
August 25-29	12th Australian Spectroscopy Conference	Sydney, Australia	Australian Academy of Science, PO Box 783, Canberra City, ACT, 2601
August 25-29	4th National Congress, Australian Institute of Physics	Melbourne, Australia	Dr. R. J. Fleming, Dept. of Physics Monash University, Clayton, Vic.. 3052
August 25-29	Symposium on the Mangrove Environment in Asia	Kuala Lumpur, Malaysia	Prof. Ahmad Nawawi, Deputy Vice-Chancellor, University of Malaya Talipon 54361, SMA 1, Kuala Lumpur Malaysia
August 25-31	International Conference Manufacturint Engineering	Melbourne, Australia	The Institution of Engineers Australia, 11 National Circuit, Barton ACT, 2600
August 25-September 1	The 10th International Cartographic Conference and the 6th General Assembly of the International Cartographic Association	Tokyo, Japan	Mr. K. Nishimura, Japan Map Center Kudan Pompian Building, 8-8, 4-chome, Kudan-Minami, Chiyoda-ku Tokyo 102
August 31-Sept. 5	General Assembly, the 15th International Geographical Union, and the 24th International Geographical Congress	Tokyo, Japan	Prof. S. Yamamoto, Rissho University 16-2-4, Ohsaki, Shinagawa-ku, Tokyo 141
August/September (Tentative)	16th Meeting of the Scientific Committee for Antarctic Research (SCAR)	Queenstown, New Zealand	Royal Society of New Zealand, Box 12249, Wellington
September 1-5	15th International Conference on the Physics of Semiconductors	Kyoto, Japan	Assistant Prof. K. Kamimura, Dept. of Physics, Faculty of Science, University of Tokyo, 1-3-7, Hongo, Bunkyo-ku Tokyo 113
September 15-19	4th Asian Symposium on Medical Plants and Spices	Bangkok, Thailand	Dr. Vichai Reutrakul, Department of Chemistry, Faculty of Science Mahidol University, Rama VI Road Bangkok 4
September 22-25	Eighth International Conference of Occupational Health in the Chemical Industry	Tokyo, Japan	Prof. N. Takemura, Jikei University School of Medicine, Minato-ku Tokyo 105
September 29-October 2	Symposium 1980 I.A.H.R. (International Association for Hydraulic Research), Section for Hydraulic	Tokyo, Japan	Prof. Dr. Masaaki Shirakura, Faculty of Engineering, University of Tokyo 7-3-1, Hongo, Bunkyo-ku, Tokyo 113 Headquarters:

Date	Title	Site	For information, contact
	Machinery Equipment and Cavitation		International Association for Hydraulic Research (IAHR), Sec. Prof. Ir. H. J. Schoemaker, Rotterdamseweg 185 PB 177, Delft. Netherlands
Sept. 29-Oct. 4	The 3rd World Conference on Medical Informatics (MEDINFO 80)	Tokyo, Japan	MEDINFO 80 Organizing Committee. c/o MEDIS-DC, Hongo P.O. Box 40 Bunkyo-ku, Tokyo 113-91
Sept. 30-Oct. 3	The 3rd International Conference on Ferrites	Kyoto, Japan	Prof. M. Sugimoto, Dept. of Electronics, Faculty of Engineering Saitama University, 255, Shimo-Ohkubo, Urawa, Saitama 338
September 30-October 4	The 8th International Conference on Computative Linguistic (COLING 80)	Tokyo, Japan	Prof. Makoto Nagao, Department of Electronics Engineering, Faculty of Engineering, Kyoto University Yoshida-Honcho, Sakyo-ku, Kyoto 606
October 1-3	The 10th International Symposium on Fault-Tolerant Computing	Kyoto, Japan	G. S. Mr. Shoji Watanabe, Kokusai Denshin Denwa Co., Ltd., 2-3-2 Nishi-Shinjuku, Shinjuku-ku, Tokyo 160
October 6-9	The 8th World Computer Congress I.F.I.P. (The International Federation for Information Processing) Congress '80	Tokyo, Japan	Information Processing Society of Japan, Kikai Shinko Kaikan, 3-5-8 Shiba-Koen, Minato-ku, Tokyo 105
October 6-10	Thirteenth Symposium on Naval Hydrodynamics	Tokyo, Japan	Prof. Takao Inui, Department of Naval Architecture, Faculty of Engineering University of Tokyo, 7-3-1, Hongo Bunkyo-ku, Tokyo 113
October 8-14	The 12th CODATA General Assembly and the 7th International CODATA Conference	Tokyo, Japan	Prof. T. Shimanouchi, College of Science, Tsukuba University, Saiki Sakura-mura, Niihari-gun, Ibaraki 300-31
October 12-17	10th World Congress on Metal Finishing (INTERFINISH '80)	Kyoto, Japan	The Metal Finishing Society of Japan Kyodo Bldg., 2, Kanda-Iwamoto-cho Chiyoda-ku, Tokyo 101
October 13-17	The 6th International Symposium on the Transport of Dangerous Goods by Sea and Inland Waterways	Tokyo, Japan	Japan Marine Surveyors and Sworn Measurer's Association, Kaiji Bldg. 1-9-7, Hatchobori, Chuo-ku, Tokyo 104

1980 – Continued

Date	Title	Site	For Information, contact
October 13-17	Electric Energy Conference	Sydney, Australia	The Institution of Engineers, Australia 11 National Circuit, Barton, ACT 2600
October 14-17	8th World Computer Congress (International Federation for Information Processing)	Melbourne, Vic. Australia	8th World Computer Congress, P.O. Box 880G, Melbourne, Vic. 3001 (Mr. A. W. Goldsworthy, State Govt. Insurance Office (Qld), Box 1453 G.P.O., Brisbane, QLD. 4001)
October 26-31	The 3rd International Meeting on Radiation Processing	Tokyo, Japan	Research Corporation Section, Administration Division, Takasaki Radiation Chemistry Research Establishment Japan Atomic Energy Research Institute, 1233 Watanukicho, Takasaki-shi Gumma 370-12
October (tentative)	RACI Cereal Chemistry Div. 30th Annual Conference	Melbourne, Australia	Dr. R. A. Orth, Aust. Wheat Board G.P.O. Box 4562, Melbourne, Vic. 3001
November 4-6	Hydrology and Water Resources Symposium	Adelaide, Australia	The Institution of Engineers, Australia 11 National Circuit, Barton, ACT 2600
November 10-14	Magneto Hydrodynamic Congress	Adelaide, Australia	The Institution of Engineers, Australia 11 National Circuit, Barton, ACT 2600
November 10-19 (tentative)	Xth International Conference on Lighthouses and Other Aids to Navigation	Tokyo, Japan	Navigation Aid Dept., Maritime Safety Agency, 2-1-3, Kasumigaseki, Chiyoda-ku, Tokyo 100
November 18-20	Microprocessors Conference	Sydney, Australia	The Institution of Engineers, Australia 11 National Circuit, Barton, ACT 2600
November 24-28	1st International Conference on Technology for Development	Canberra, Australia	The Institution of Engineers, Australia 11 National Circuit, Barton, ACT 2600
December 1-5	4th International Symposium on Nitrogen Fixation	Canberra, Australia	Dr. A. H. Gibson, CSIRO Div. of Plant Industry, Box 1600, Canberra, ACT 2601
December 4-5	Lubrication Conference	Melbourne, Australia	The Institution of Engineers, Australia 11 National Circuit, Barton, ACT 2600

1981

Date	Title	Site	For information, contact
January 25-31	International Symposium on Erosion and Sediment Transport in Pacific Rim Steeplands	Canterbury, New Zealand	Royal Society of New Zealand, Box 12249, Wellington
January 31-February 4	Conference on Large Earthquakes	Napier, New Zealand	Royal Society of New Zealand, Box 12249, Wellington
February 11-18	International Conference on Soils with Variable Charge	Massey, New Zealand	Royal Society of New Zealand, Box 12249, Wellington
April 26-May 1	1st Asian and Pacific Chemistry Congress	Singapore, Republic of Singapore	The Congress Secretary, 1st Aspac Congress, Singapore Professional Center, 129B Block 23 Ontram Park, Singapore 0316, Republic of Singapore
May 11-15	4th International Conference on Trace Metabolism in Man & Animals (TEMA)	Perth, Australia	Australian Academy of Science, P.O. Box 783, Canberra City, ACT, 2601
May 11-15	Australian Biochemical Society Annual Meeting	Adelaide, Australia	Dr. H. C. Robinson, Dept. Biochemistry, Monash University, Clayton, Vic. 3168
May 16-22	The 12th IAPH (International Association of Ports and Harbors) Conference	Nagoya, Japan	Nagoya Port Authority, 1-8-21 Irifune Minato-ku, Nagoya 455
May (Tentative)	34th Annual Metals Congress	Sydney, Australia	undecided
May (Tentative)	Electric Energy Manufacturing Conference	Australia	The Institution of Engineers, Australia 11 National Circuit, Barton, ACT 2600
July 19-24	8th International Congress of Pharmacology–IUPHAR–	Tokyo, Japan	The Japanese Pharmacological Society Gatsukai Center Bldg. 4F., 2-4-16, Yayoi, Bunkyo-ku, Tokyo 113 Headquarters: International Union of Pharmacology c/o Roche Research Center, Nutley New Jersey 07110, U.S.A.
July 27-August 1	The 4th International Congress of Biorheology	Tokyo, Japan	Japanese Society of Biorheology, c/o Physics Laboratory, Keio University 4-1-1, Hiyoshi, Kohoku-ku, Yokohama 223. Headquarters: International Society of Biorheology, c/o Division of Neurology, University of

1981 – Continued

Date	Title	Site	For information, contact
			Oregon, Health Science Center, Portland, Oregon, 97201, U.S.A.
August 21-28	XIII International Botanical Congress	Sydney, N.S.W. Australia	Executive Secretary, Dr. W. J. Cram School of Biological Sciences, University of Sydney, N.S.W., 2006
August 24-28	International Federation of Automatic Control (IFAC) 8th Triennial World Congress	Kyoto, Japan	Prof. Y. Sawaragi, Dept. of Applied Mathematics and Physics, Faculty of Engineering, Kyoto University Yoshida-Honmachi, Sakyo-ku, Kyoto 606
August (Tentative)	17th Annual Congress of the Australian and New Zealand College of Psychiatrists	Victoria, Australia	undecided
September 1-5	9th ICAS-XXII CSI (9th International Conference on Atomic Spectroscopy and XXII Colloquium Spectroscopium Internationale)	Tokyo, Japan	The Japan Society for Analytical Chemistry, 9th ICAS-XXII CSI Gotanda-Sanhaitsu, 26-2, 1-chome Nishi-qotanda, Shinagawa-ku, Tokyo 141
September 12-18	The 10th International Congress of Electroencephalography and Clinical Neurophysiology	Kyoto, Japan (undecided)	International Conference, Organizers, Inc., Crescent Plaza 103, 2-4-6 Minato-ku, Tokyo 107
September 17-21	The 14th World Congress of International League against Epilepsy and the 13th Symposium of the International Bureau of Epilepsy	Kyoto, Japan	International Conference Organizers, Inc., Crescent Plaza 103, 2-4-6 Minami-Aoyama, Minato-ku, Tokyo 107
September 20-23	1981 International Symposium on Gallium Arsenide and Related Compounds	Kanagawa, Japan	Prof. H. Yanai, Dept. of Electronic Engineering, University of Tokyo 7-3-1, Hongo, Bunkyo-ku, Tokyo 113
September 20-25	12th World Congress of Neurology	Kyoto, Japan	Simul International, Inc., No. 9, Kowa Bldg., 1-8-10, Akasaka, Minato-ku Tokyo 107
September 23-25	Australasian Society of Nephrology joint meeting with Cardiac Society	Brisbane, Australia	Dr. B. M. Saker, Renal Unit, Royal Perth Hospital, Perth, WA, 6000
September (tentative)	International Rock Mechanics Symposium on Weak Rock– Soft, Fractured and Weathered Rock–	Tokyo, Japan	Japan Society of Civil Engineers, 1-chome, Yotsuya, Shinjuku-ku, Tokyo 160

1981 – Continued

Date	Title	Site	For information, contact
September/ October (Tentative)	International Union Conservation of Nature and Natural Resources	Christchurch, New Zealand	Lincoln College, Christchurch Canterbury
		1982	
May 23-28	16th International Congress of Dermatology (CID)	Tokyo, Japan	Japan Convention Services, Inc. Nippon Press Center 8F, 2-2-1 Uchisaiwai-cho, Chiyoda-ku, Tokyo 100
Mid-July (tentative)	The 5th International Congress of Plant Tissue	Yamanashi, Japan	Assistant Prof. A. Komamine, Dept. of Botany, Faculty of Science, University of Tokyo, 7-3-1, Hongo, Bunkyo-ku Tokyo 113
Aug. 9-Sept. 3	The 5th International Congress of Pesticide Chemistry IUPAC	Kyoto, Japan	Rikagaku Kenkyusho, 2-1, Hirosawa Wako, Saitama 351
August 15-21	International Biochemical Congress	Perth, Australia	Australian Academy of Science and International Union of Biochemistry P.O. Box 783, Canberra, ACT 2601
August (Tentative)	The Royal Australian Chemical Institute 7th National Convention	Canberra, Australia	Executive Secretary, RACI HQ, 191 Royal Parade, Parkville, Vic. 3052
August (tentative)	1982 International Conference on Solid State Devices	Tokyo, Japan	The Japan Society of Applied Physics Kikai-Shinko-Kaikan, 5-8, 3-chome Shibakoen, Minato-ku, Tokyo 105
August (tentative)	International Biochemistry Congress	Perth, W.A. Australia	Australian Academy of Science, P.O. Box 783, Canberra City, A.C.T. 2601
September (Tentative)	6th International Symposium on Contamination Control	Tokyo, Japan	Japan Air Cleaning Association, 6-7-5 Soto-Kanda, Chiyoda-ku, Tokyo 101
October 4-6 (Tentative)	Third International Dental Congress on Modern Pain Control	Tokyo, Japan	Japan Convention Service, Inc., Nippon Press Center 8F., 2-2-1, Uchisaiwai-cho Chiyoda-ku, Tokyo 100
undecided	International Conference on Mass Spectroscopy	Hawaii, U.S.A.	Prof. T. Tsuchiya, Basic Science Lecture Room, Chiba Institute of Technology, 1-17-2, Tsudanuma, Narashino Chiba 275

1983

Date	Title	Site	For information, contact
May 10-12	Royal Australian College of Physicians ASM	Sydney, Australia	RACP, 145 Macquarie Street, Sydney NSW, 2000
May (Tentative)	52nd ANZAAS Conference	Perth, Australia	
August 17-24	4th International Congress in Plant Pathology	Melbourne, Australia	Australian Academy of Science Australian Plant Pathology Society PO Box 783, Canberra City, ACT 2601
August 28/ September 2	29th International Congress of Physiology	Sydney, Australia	Australian Academy of Science, PO Box 783, Canberra City, ACT 2601
October (Tentative)	71st FDI Annual World Dental Congress	(Tokyo) (Tentative) Japan	Japan Dental Association (Japanese Association for Dental Science) 4-1-20, Kudan-kita, Chiyoda-ku Tokyo 102
October (Tentative)	8th International Conference on Calcium Regulating	(Kobe) (Tentative) Japan	Prof. T. Fujita, 3rd Division, Dept. of Medicine, School of Medicine, Kobe University, 7-13, Kusunoki-cho Ikuta-ku, Kobe 650

COLOR APPEARANCE
AIC MIDTERM TOKYO SYMPOSIUM '79
INTERNATIONAL COLOR ASSOCIATION

Rudolph J. Marcus

An international symposium on color appearance was held 16-17 August, 1979, in Tokyo, Japan. Although no one from ONR/Tokyo was at this meeting, the abstracts of papers given at this meeting are available at this office and specific ones can be sent to those who request them.

A listing of speakers at this meeting, their addresses, and titles of their papers follows.

Name and Address	*Title*
C. J. Bartleson Research Laboratories Eastman Kodak Company Bldg. 59, Kodak Park Rochester, N.Y. 14650 U.S.A.	Chromatic adaptation
S. S. Bergstroem Dept. of Applied Psychology Umea University S-901 87 UMEA Sweden	Colour constancy as hue constancy or object constancy
Y. Nayatani Electrotechnical Lab. Osaka Branch 1-1 Ichinotsubo Nakoji, Amagasaki-shi Hyogo 661 Japan	On the uniform color space under illuminant A
R. M. Boynton Dept. of Psychology University of California San Diego La Jolla, CA 92093 U.S.A.	The effect of lights of long wavelength upon discriminations mediated by the blue-sensitive mechanism
L. Sivik University of Gothenburg Psychol Inst., Fack, S-400 20 Gothenburg Sweden	Direct psychometric scaling of color rendering

R. W. G. Hunt
Research Division
Kodak Limited
Headstone Drive, Harrow
Middlesex, HA1 4TY
Great Britain

Major attributes in colour appearance and their quantification

E. Ganz
CIBA-GEIGY
Wenkenstr. 85
CH-4125 Richen
Switzerland

Individual differences in perceiving whiteness

T. Indow
Dept. of Psychology
Keio University
2-15-45 Mita
Minato-ku, Tokyo 108
Japan

Perceptual components in Munsell colors

P. L. Walraven
Inst. for Perception T.N.O.
Kampweg 5
Soesterberg
The Netherlands

Colour recognition of signal and surface colours

N. Akita
Psychology Lab.
Kyoto Inst. of Tech.
Matsugasaki-goshokaido-cho
Sakyo-ku, Kyoto 606
Japan

Unique hues

P. K. Kaiser
Dept. of Psychology
York University
Downsview, Ontario, M3J 1P3
Canada

Spectrosensitivity functions determined by the rapid scan technique

IMEKO SYMPOSIUM ON FLOW MEASUREMENT AND CONTROL IN INDUSTRY

Rudolph J. Marcus

An international symposium on Flow Measurement and Control in Industry was held 13-16 November 1979 in Tokyo, Japan. Although no one from ONR/Tokyo was at this symposium, the abstracts of papers given at this symposium are available at this office and specific ones can be sent to those who request them.

A listing of speakers at this meeting, their addresses, and titles of their papers follows.

Name and Address	*Title*
Antal Szabo Research and Development Inst. of MMG Automation Works H-1300 Budapest Pf. 59, Rokolya u. 1-13, Hungary	Calibration rig for liquid and gas flowmeters using a new harp-type volumetric flow measurement equipment
R. W. Miller The Foxboro Company Foxboro, MA 02035 U.S.A.	National and international orifice coefficient equations compared to laboratory data
Xie Ji-ji National Institute of Metrology Beijing People's Republic of China	Calibration of the pipe provers
Fang Zong-liang and Wang Zi-he National Institute of Metrology Beijing People's Republic of China	Method of gas calibration for standard tank
Su Yan-shiun National Institute of Metrology Beijing People's Republic of China	The accuracy evaluation of the calibrating devices of liquid flowmeters
Wang Zi-he National Institute of Metrology Beijing People's Republic of China	The theoretical analysis of the quadrant compensation of the bell-prover

T. Satori
Hokushin Electric Works, Ltd.
30-30 Shimo-Maruko
Ohta-ku, Tokyo 144
Japan

A large capacity calibration rig for electro-magnetic flowmeters

K. G. Ranga Raju
Civil Engineering Dept.
University of Roorkee
Roorkee 247672
India

Comprehensive weir discharge formulae

K. G. Ranga Raju
Civil Engineering Dept.
University of Roorkee
Roorkee 247672
India

Discharge characteristics of a sluice gate located on a raised crest

J. G. Drenthen
Rijkswaterstaat
Hydro-instrumentation Dept.
Nijverheidsstraat 2
Rijswijk (Z. H.)
The Netherlands

A new accurate stilling well for high-velocity flows

P. J. H. Builtjes
Netherlands Organization for Applied Scientific Research
M.T./T.N.O.
Laan van Westenenk 501
Apeldoorn
The Netherlands

A new wave and tidal height pressure sensor probe for use in high-velocity flows

M. Kawata
National Research Lab. of Metrology
10-4, 1-chome, Kaga
Itabashi-ku, Tokyo 173
Japan

Servo P-D flowmeter

Iwao Ohtani
Research Laboratory
TOKICO Ltd.
3-6-1, Fujimi, Kawasaki-ku
Kawasaki-shi 210
Japan

New flow meter with four lobe helical rotors

Takehiko Kawase
Waseda University
3-4-1 Okubo, Shinjuku-ku
Tokyo 160
Japan

Oscillatory fluid flow caused by PD meters

Kamekichi Shiba
Faculty of Engineering
Toyo University
2100, Nakanodai, Kujirai
Kawagoe, Saitama 350
Japan

Mass flowmetry by a movable tube flowmeter with a positive displacement meter

Zhai Xiu-zhen
National Institute of Metrology
Beijing
People's Republic of China

Evaluation of accuracy for flow coefficient of standard nozzle

R. W. Davis
Fluid Engineering Division
National Bureau of Standards
Washington, D.C. 20234
U.S.A.

Numerical modeling of swirling laminar orifice flow

Mohan Lal
National Physical Lab.
Hillside Road
New Delhi 110012
India

A new flowmeter for measurement of throughput in vacuum systems

Yoshisuke Yamashita
Sophia University
Dept. of Science and Tech.
7 Kioicho, Chiyoda-ku
Tokyo 102
Japan

The measurement of laminar pulsating flow with a Venturi meter

Hiromichi Toyota
University of Tokyo
Faculty of Engineering
7-3-1, Hongo, Bunkyo-ku
Tokyo 113
Japan

Pressure fluctuations and pulsation error of differential pressure gas flow meters

Noboru Nakatani
Dept. of Precision Engineering
Faculty of Engineering
Osaka University
Yamada-Kami, Suita 565
Japan

The flow analysis of the vortex shedding flowmeter by the laser doppler velocimeter

Masaki Takamoto
National Research Lab. of Metrology
10-4, 1-chome, Kaga
Itabashi-ku, Tokyo 173
Japan

A vortex flowmeter with a fluidic oscillation system

Hiro Yamasaki
Faculty of Engineering
Dept. of Math. Engineering and
Instrumentation Physics
University of Tokyo
7-3-1, Hongo, Bunkyo-ku
Tokyo 113
Japan

A unified approach to hydrodynamic oscillators with fluidic flowmeter

Takehiro Sawayama
Yokogawa Electric Works, Ltd.
2-9-32 Nakacho Musashino-shi
Tokyo 180
Japan

New vortex flowmeter with wide application range

Kiichi Tsuchiya
Dept. of Mechanical Engineering
Waseda University
3-4-1, Okubo, Shinjuku-ku
Tokyo 160
Japan

Experimental study on the withdrawal of sludge deposit by the tornado-like vortex flow

Yousif A. Al-Khazraji
Imperial College of Science and
Technology
London
England

New design concepts for electromagnetic flowmeters for the process industries Some advantages and disadvantages

Miroslav Kotal
Czech Technical University
Prague
Czechoslovakia

Theoretical and practical magnetic field application in electromagnetic flowmeters

Sakae Ishikawa
Yamatake-Honeywell Co. Ltd.
28-1, 4-chome, Nishirokugo
Ohta-ku, Tokyo 144
Japan

Submersible electromagnetic flowmeter

K. Kuromori
Hokushin Electric Works, Ltd.
3-30 Shimo-Maruko,
Ohta-ku, Tokyo 144
Japan

A magnetic flowmeter having dual signal detection system

A. A. Meister
Tallinn Polytechnic Inst.
Tallinn
U.S.S.R.

Integrating digital electromagnetic flowmeter

Mahmoud Tarabad Imperial College of Science and Technology London England	Electromagnetic flowmeters for sodium-cooled nuclear reactors
Sakuki Inagaki Tokyo Keiki Co. Ltd. 2-16 Minamikamata Ohta-ku, Tokyo 144 Japan	New ultrasonic flow measurements systems for sewage and waste water
Hisashi Yada Fuji Electric Co., Ltd. Tokyo Works 1 Fuji-cho, Hino Tokyo 191 Japan	Flow measurement with TLL (Time-Locked-Lood) ultrasonic flowmeter
Takeshi Hirayama Hitachi Research Lab. Hitachi Ltd. 4026 Kujimachi, Hitachi Ibaraki-ken 319-12 Japan	Temperature compensation of ultrasonic flowmeter
Kenkichi Ohba Faculty of Engineering Osaka University Yamada-Kami, Suita Osaka 565 Japan	Velocity measurements of both phases in two-phase flow using laser doppler velocimeter
Hiroyasu Nahata Dept. of Mathematical Engineering and Instrumentation Physics Faculty of Engineering University of Tokyo 7-3-1, Hongo, Bunkyo-ku Tokyo 113 Japan	Laser doppler velocimetry using a microcomputer
Toshio Fukuda Mechanical Engineering Lab. 12-1, 4-chome, Igusa Suginami-ku, Tokyo 167 Japan	Leak detection and its localization in a pipeline system
Kageo Akizuki Waseda University 3-4-1, Okubo, Shinjuku-ku Tokyo 160 Japan	Detection of water leakage point using cross correlation method

Noboru Fujimori
Nippon Kokan, K.K.
1-2, 1-chome, Marunouchi
Chiyoda-ku, Tokyo 100
Japan

A study on the leak detection system based on in-out flow difference method

R. C. Mottram
Dept. of Mechanical Engineering
University of Surrey
Guildford
U.K.

A sampling technique for measuring high temperature gas flows

Yoshihiro Fujii
Nippon Steel Corp.
Sakai Works
1 Chikko-Yahatacho, Sakai
Osaka 590
Japan

A new pitot-thermal flowmeter

Masao Yamada
Metering Design Dept.
Tokico Ltd.
3-6-1, Fujimi, Kawasaki-ku
Kawasaki-shi 210
Japan

Insertion turbine meter for industrial waste gas measurement

Hidekazu Asada
Tokyo Keiki Co. Ltd.
16, 2-chome, Minami-kamata
Ohta-ku, Tokyo 144
Japan

Ultrasonic flowmeter for exhaust gases in stacks

Satoshi Honda
Dept. of Mathematical Engineering
and Instrumentation Physics
Faculty of Engineering
University of Tokyo
7-3-1, Hongo, Bunkyo-ku
Tokyo 113
Japan

Center frequency measurement of the signals of laser doppler velocimeters and vortex flowmeters using the zero counting method

Yoshio Kurita
Yokogawa Electric Works Ltd.
2-9-32 Naka-cho, Musashino-shi
Tokyo 180
Japan

Flow velocity measurement using spatial filter

Yasutaka Tamura
Dept. of Mathematical Engineering
and Instrumentation Physics
Faculty of Engineering
University of Tokyo
7-3-1, Hongo, Bunkyo-ku
Tokyo 113
Japan

Measurement of spatial distribution of flow velocity vector using long-wavelength holography

Toshihiko Inoue
Faculty of Engineering Science
Osaka University
1-1, Machikaneyama
Toyonaka, Osaka 560
Japan

Automatic flow pattern recognition of gas-liquid two-phase mixture in a vertical pipe

H. H. Dijstelbergen
N. V. Nederlandse Gasunie
Postbox 19, Groningen
The Netherlands

Control theory applied to flow measurement

Nandana Vittal
University of Roorkee
Roorkee 247672
India

Pipe-net meter

Yasuyuki Matsuo
Faculty of Engineering
Keio University
3-14-1 Hiyoshi, Kohoku
Yokahama 223
Japan

Flow control in aerosol sampling and evaluation of size distributions

V. D. Zotov
Institute of Control Sciences and
Inst. of Testing Machines
Moscow
U.S.S.R.

Design and development of explosion-proof continuous dosers

Koichiro Akashi
Nagasaki Technical Inst.
Mitsubishi Heavy Ind., Ltd.
1-1 Akunoura-machi
Nagasaki 850-91
Japan

Development of new flow rectifier for shortening upstream straight pipe length of flow meter

F. E. Wagner
Institut fuer Mess- und
Regelungstechnik
Technische Universitaet Berlin
Kurfuerstendamm 195
D-1000 Berlin 15

On the development of a self-compensating drag plate flowmeter

Noboru Kojima
Faculty of Engineering
Meiji University
5158 Ikuta, Tama-ku
Kawasaki-shi 214
Japan

A measurement principle of the slippage of the fluid over wall

BULLETIN INDEX

LOCATION OF INSTITUTION

☆ U. S. GOVERNMENT PRINTING OFFICE : 1980 623-767/1503